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(54) **ROLLER GRILL**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(51) **Int. Cl.**
A47J 37/04 (2006.01)

(52) **U.S. Cl.**
CPC *A47J 37/048* (2013.01)
USPC **99/441**; 99/442

(58) **Field of Classification Search**
USPC .... 99/441, 339, 393, 402, 422, 423, 426, 99/442, 443 R, 443 C, 448, 449
See application file for complete search history.

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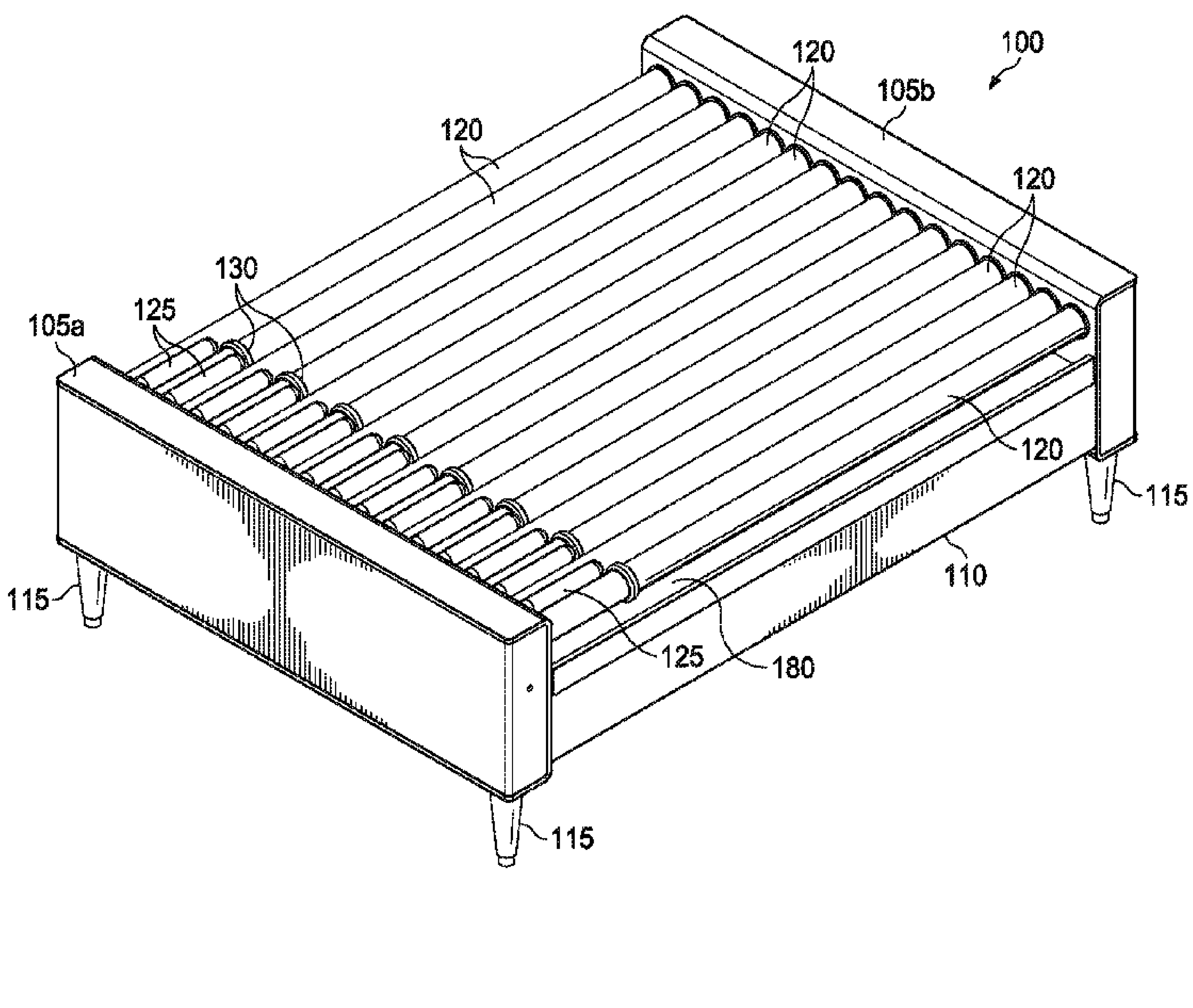
(57) **ABSTRACT**

A roller grill includes a housing structure adapted to support the roller grill; a plurality of tubes having outer surfaces adapted to transfer heat to a pre-cooked food product; a plurality of rollers mounted in a row, each roller mounted on an end of a corresponding tube and including a plurality of detented projections extending from a circumferential surface of the roller; and a drive assembly. The drive assembly includes a continuous looped surface coupled to a motor shaft and contactingly engaged with the detented projections of the plurality of rollers. The roller grill further includes a protrusion mounted to the housing structure and in contacting engagement with the continuous looped surface, such that the continuous looped surface is contactingly engaged with at least two detented projections of each roller of the plurality of rollers mounted in the row.

12 Claims, 21 Drawing Sheets



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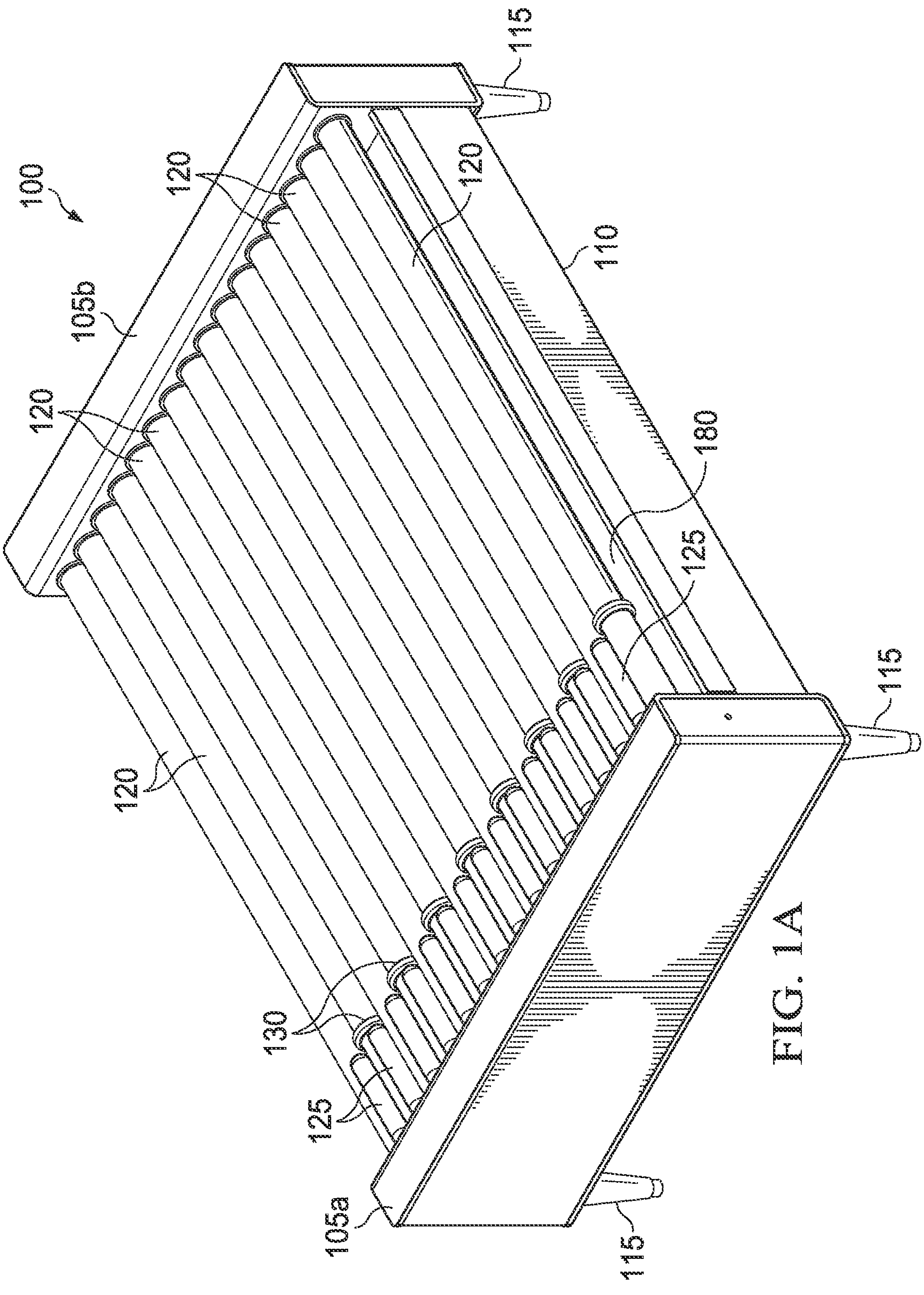

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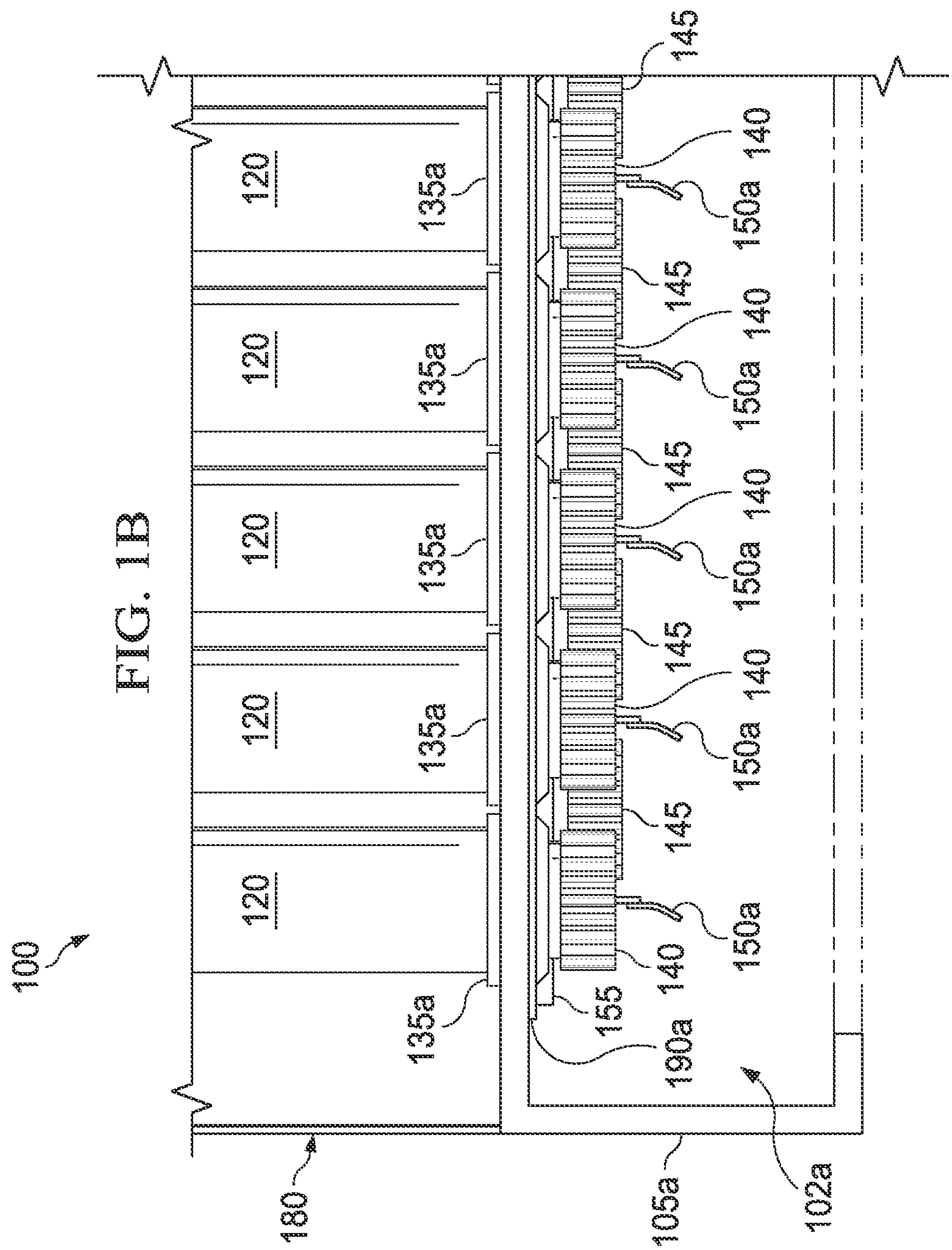
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102a

FIG. 1B

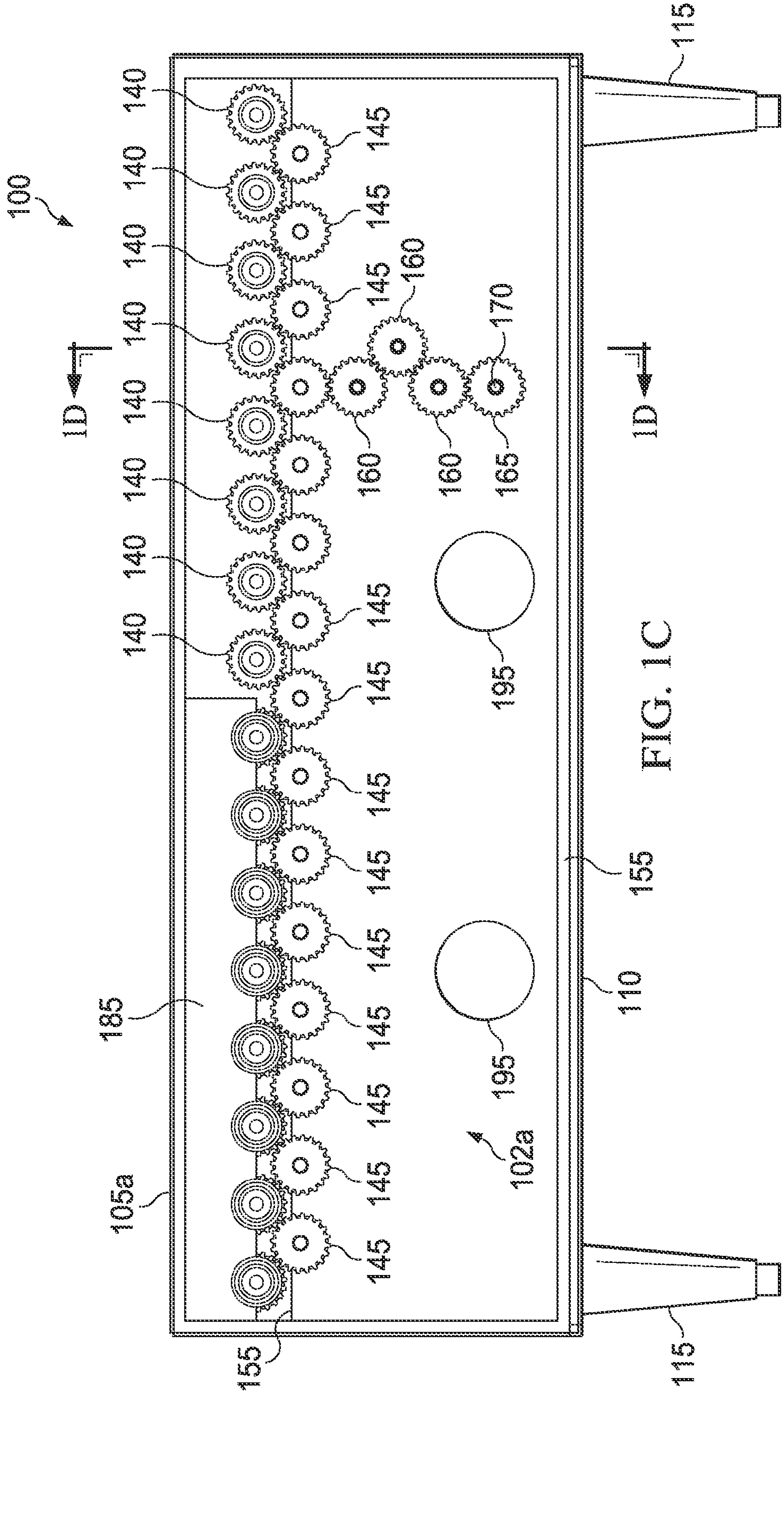

FIG. 1C

FIG. 1E

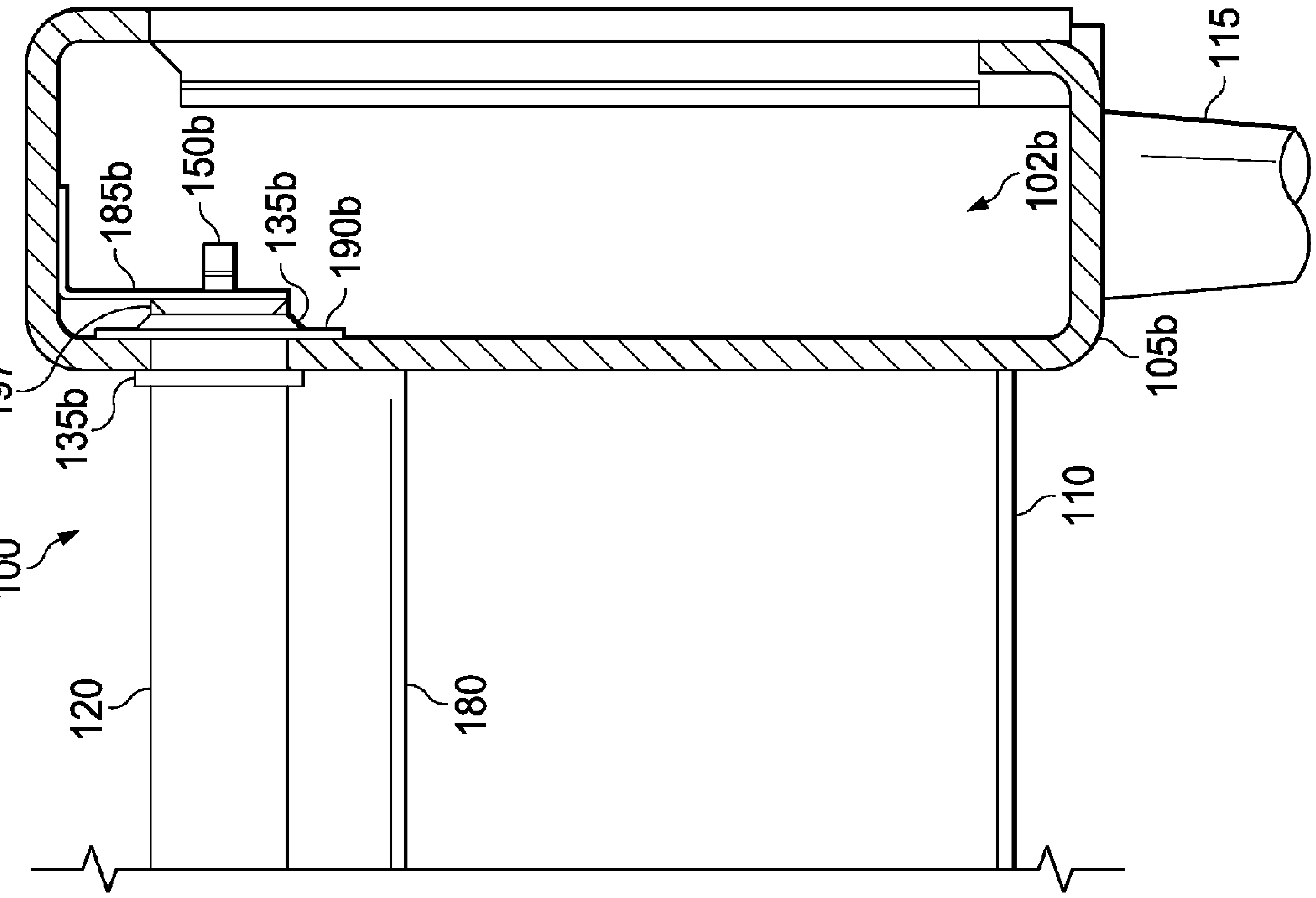

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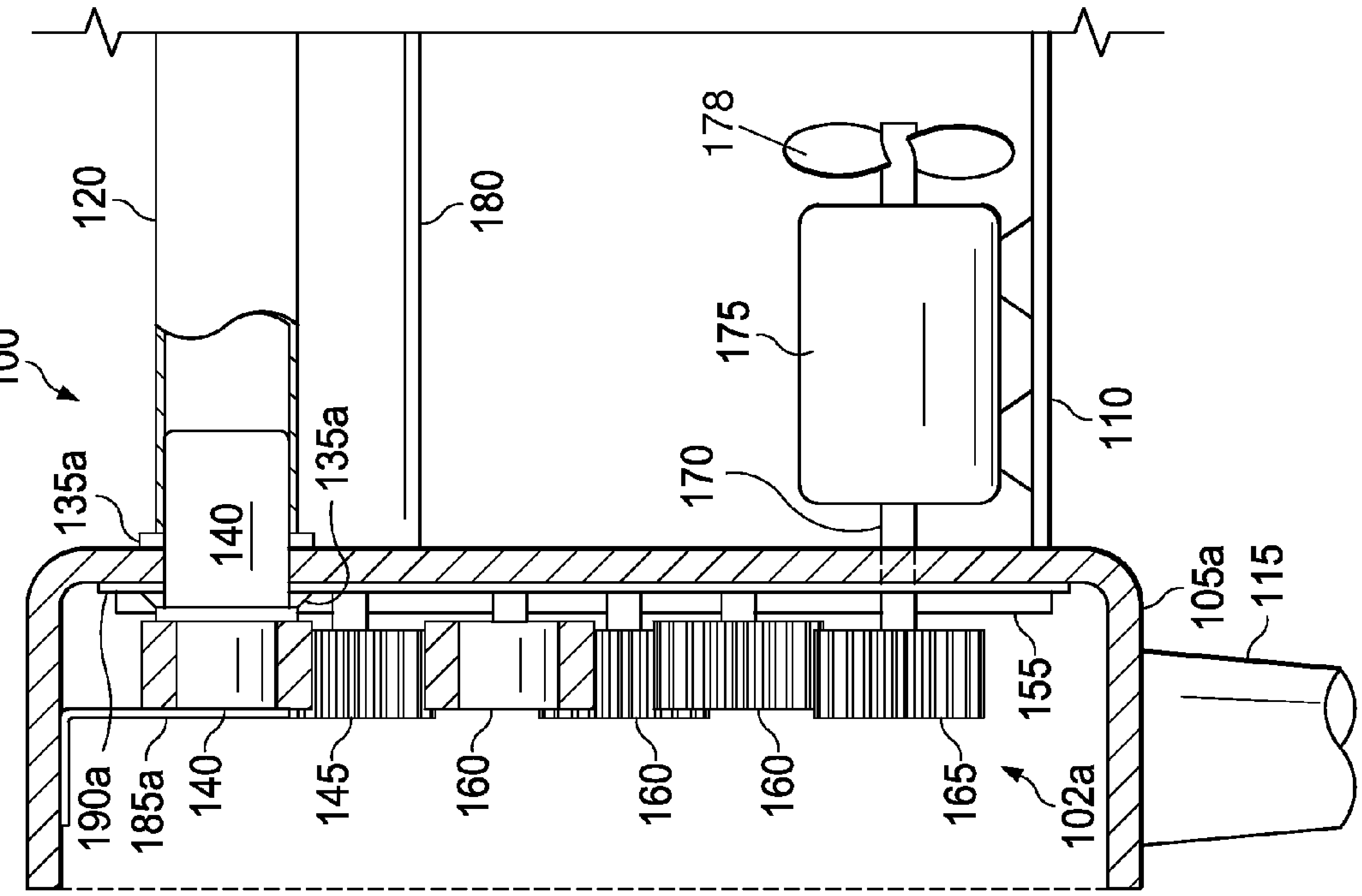
FIG. 1D



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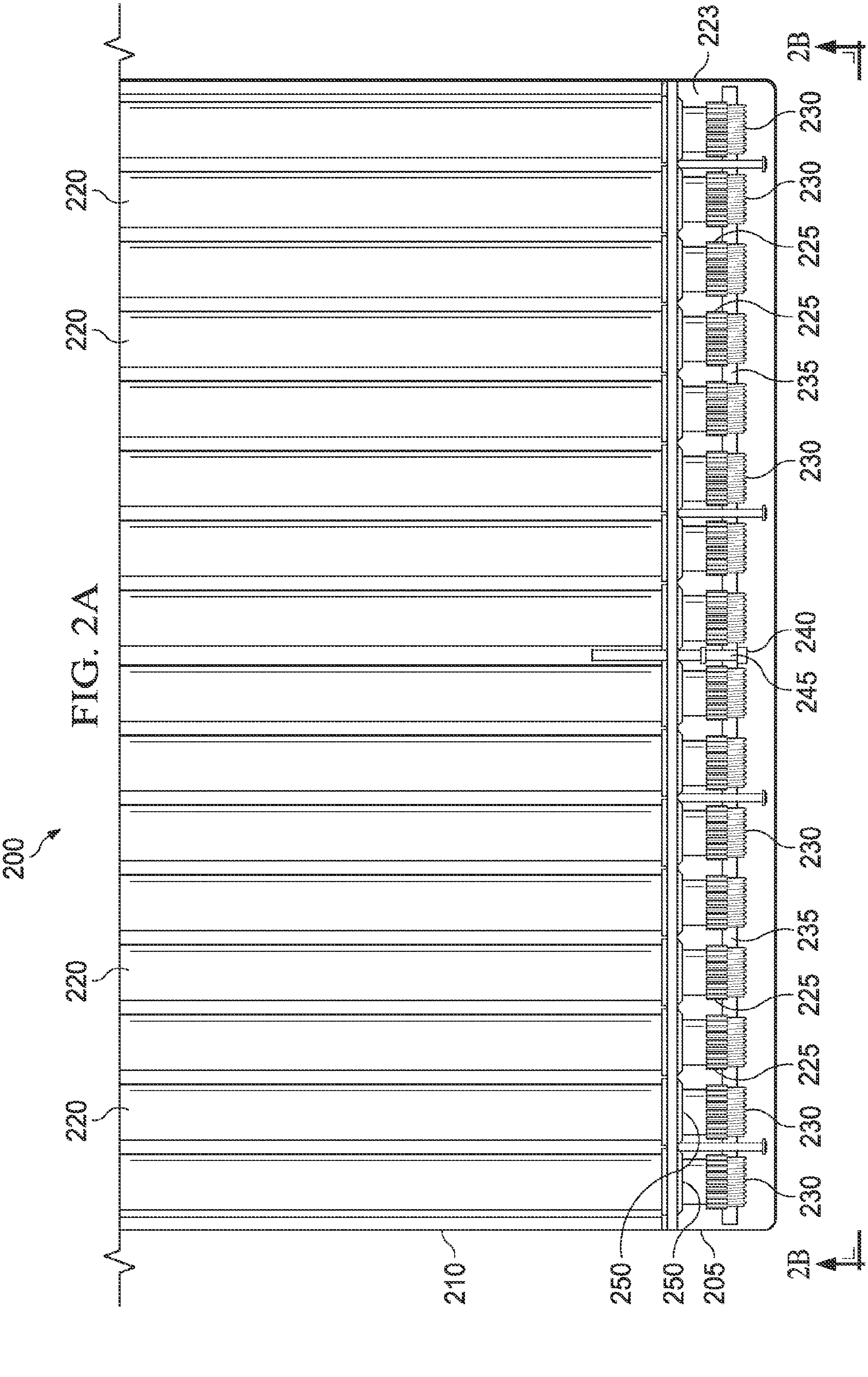
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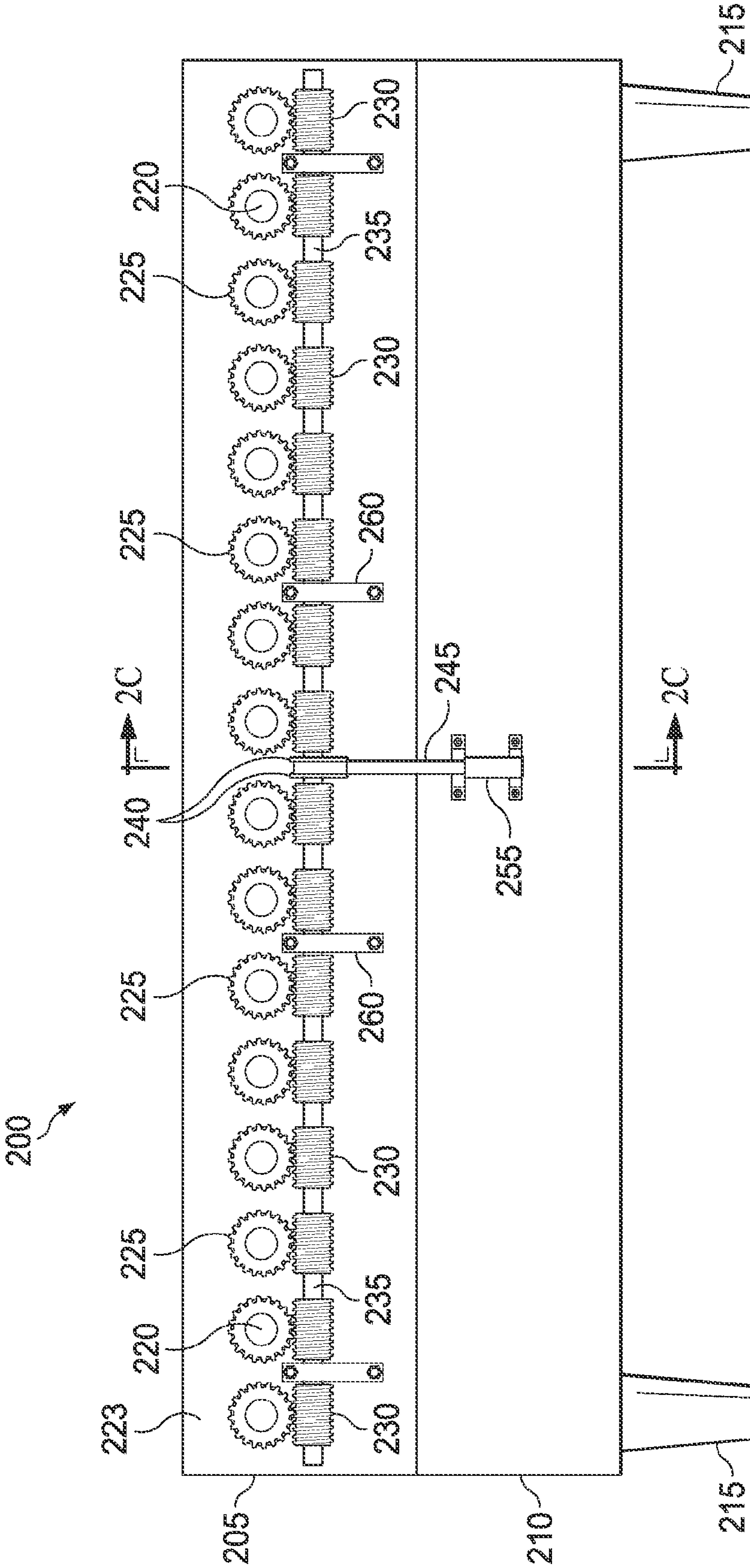
FIG. 2A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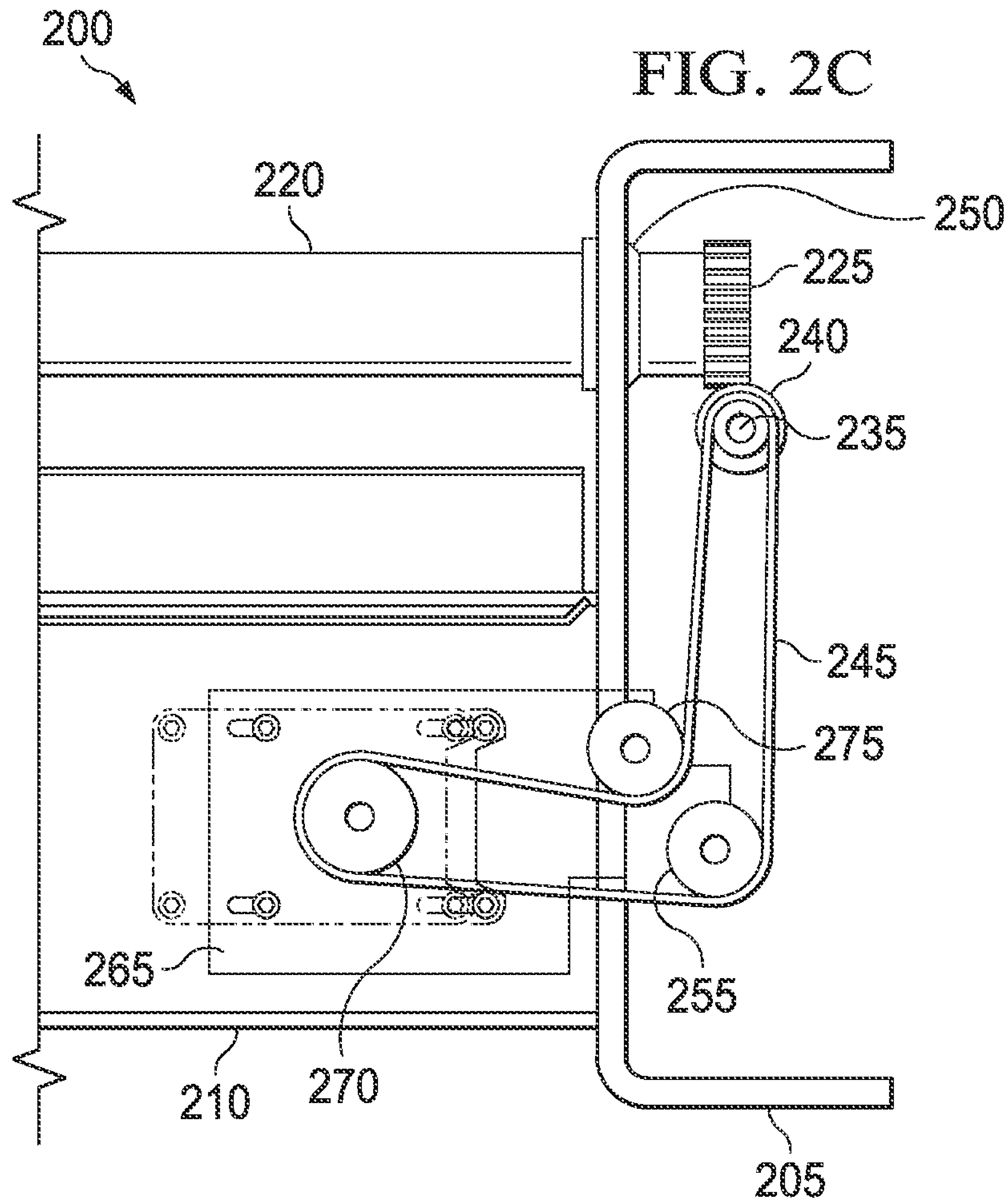
2C

FIG. 2B

FIG. 2C



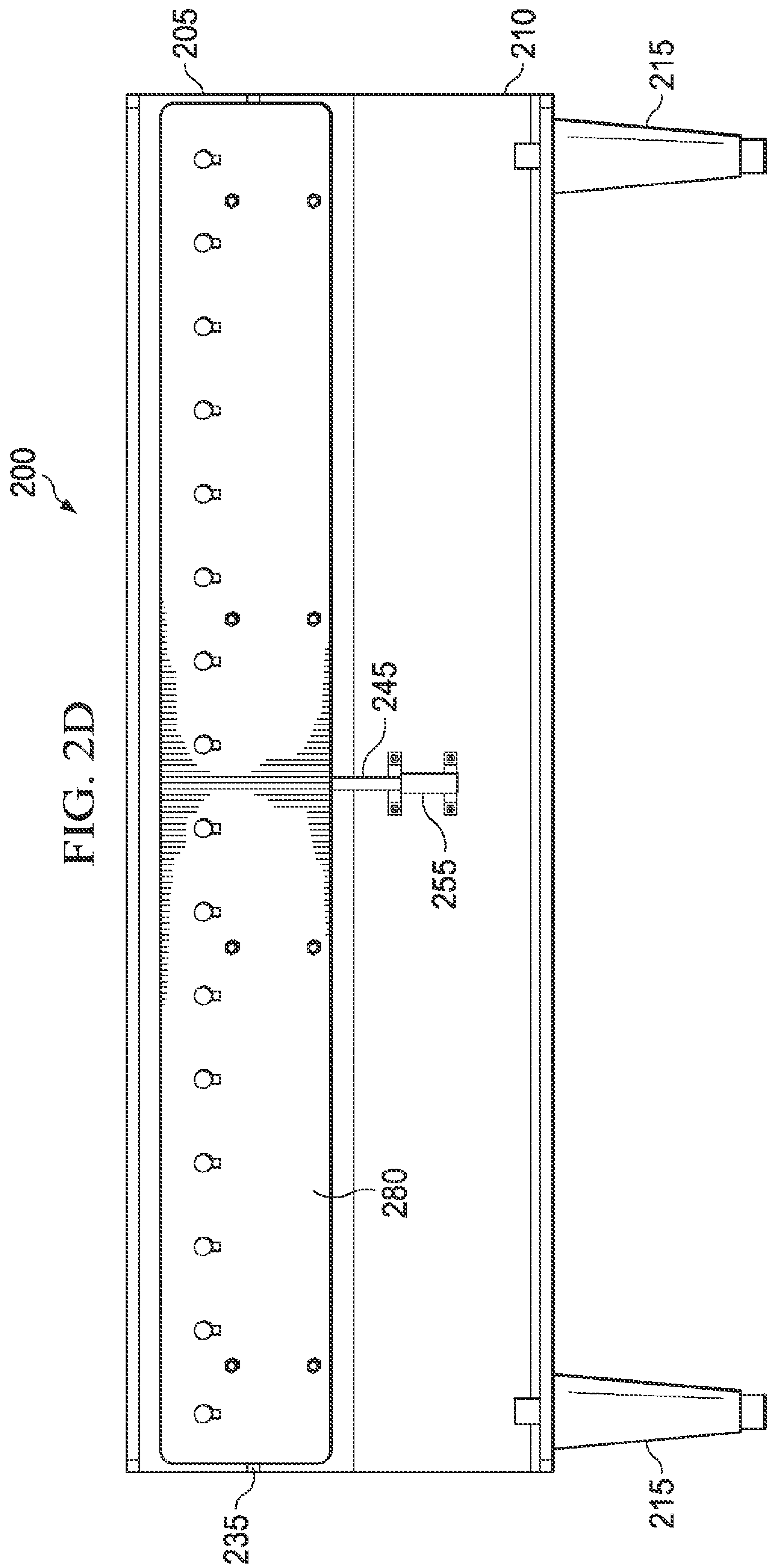


FIG. 2D

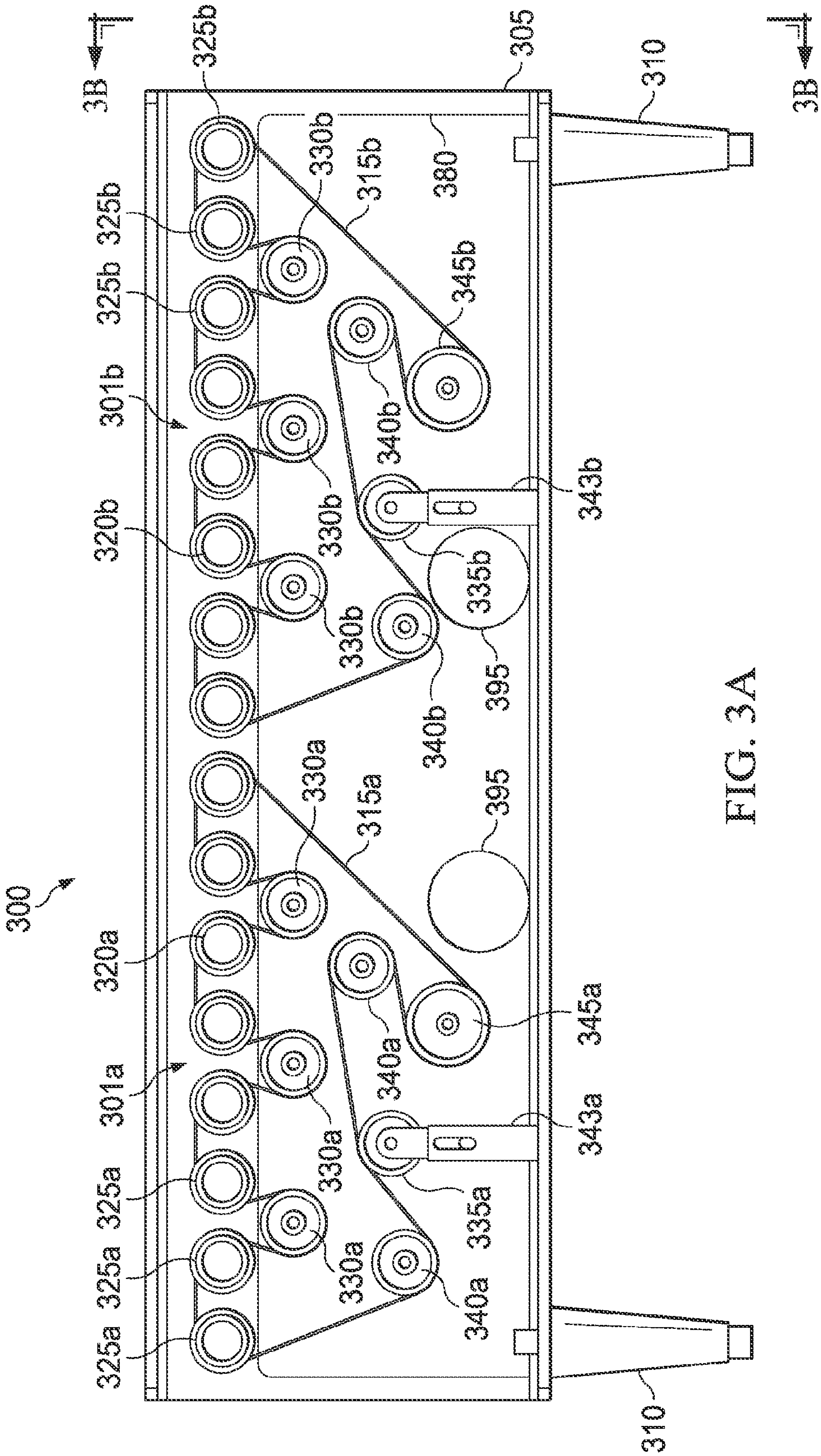

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FIG. 3A

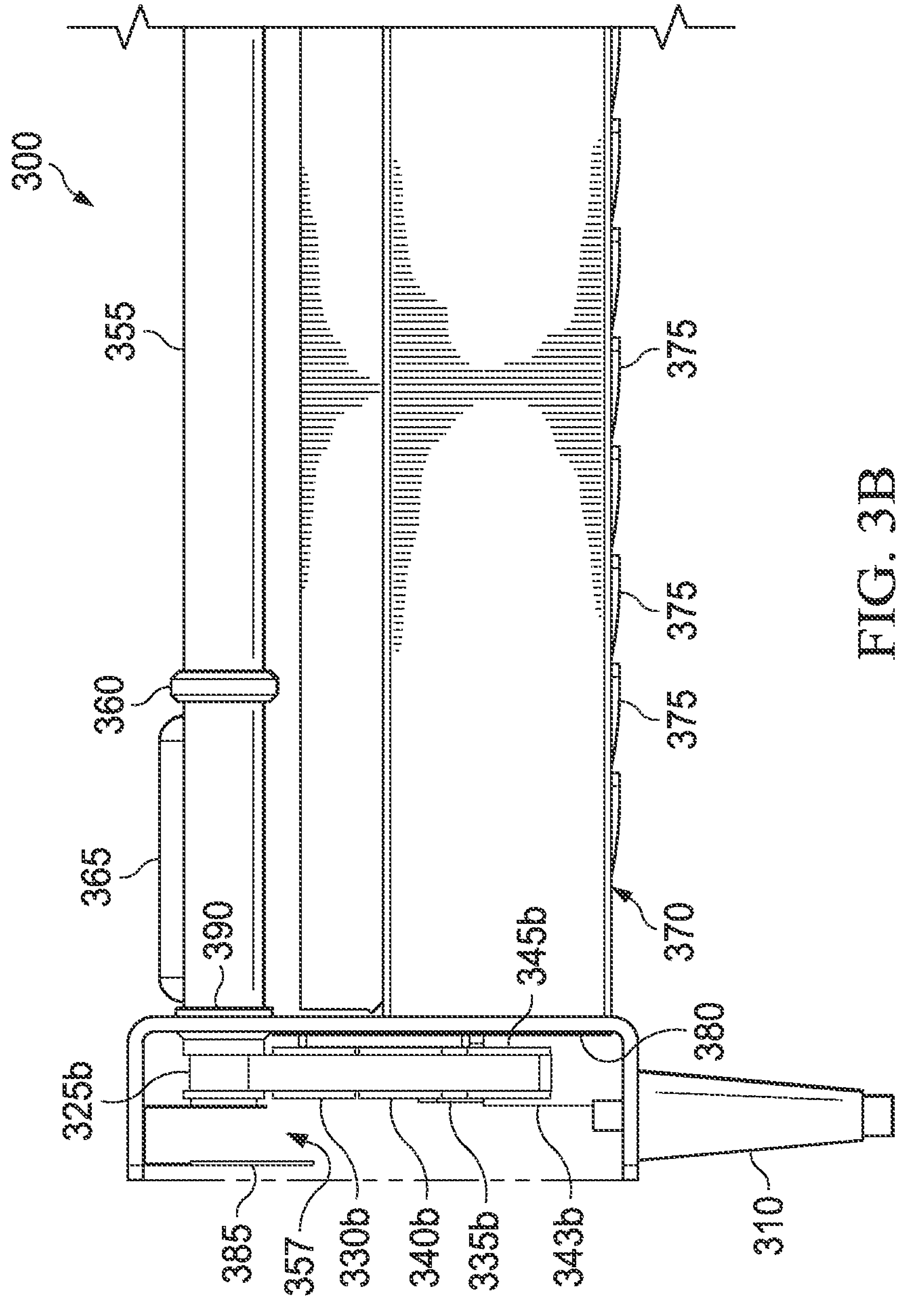
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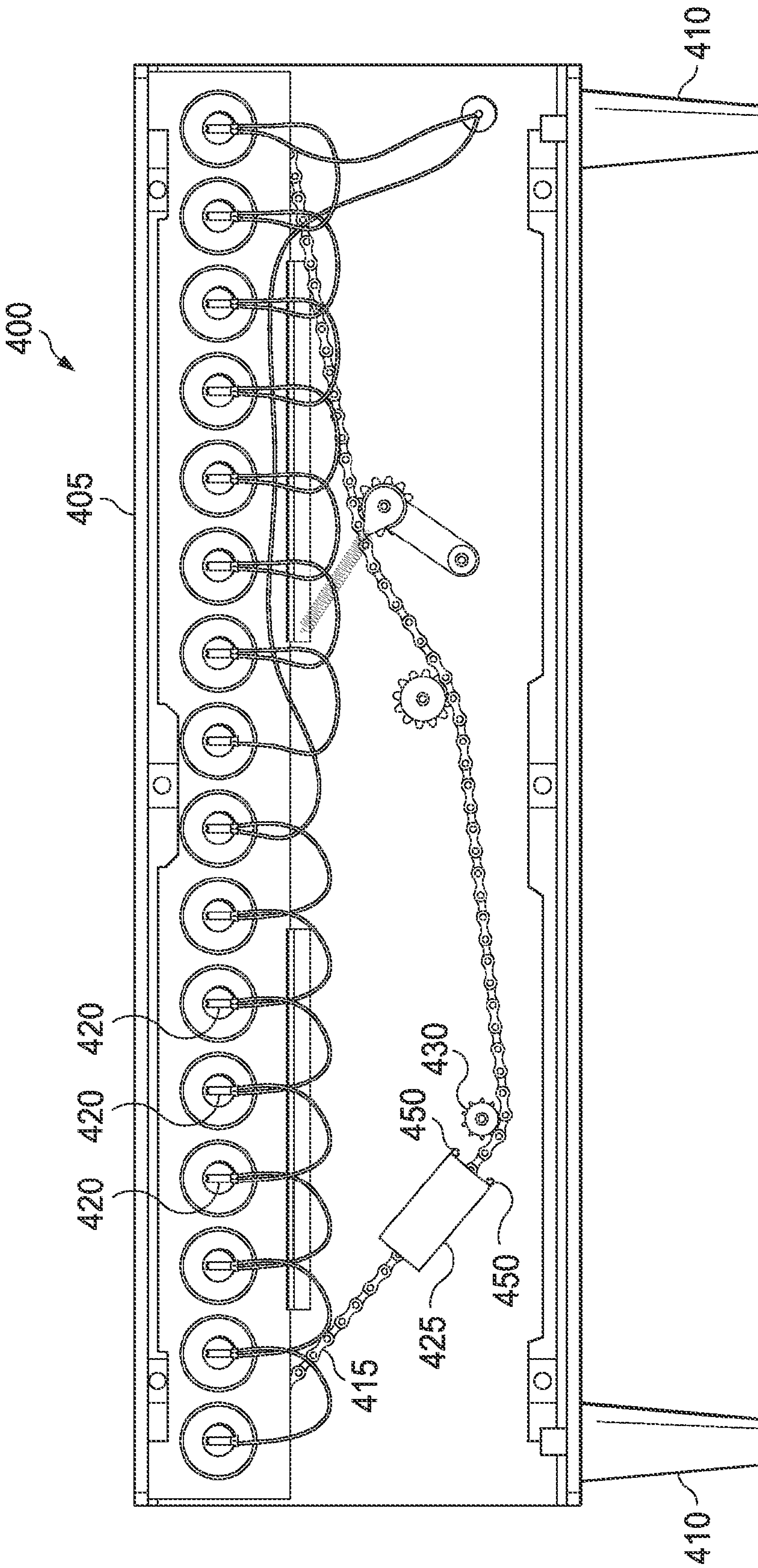
FIG. 3B



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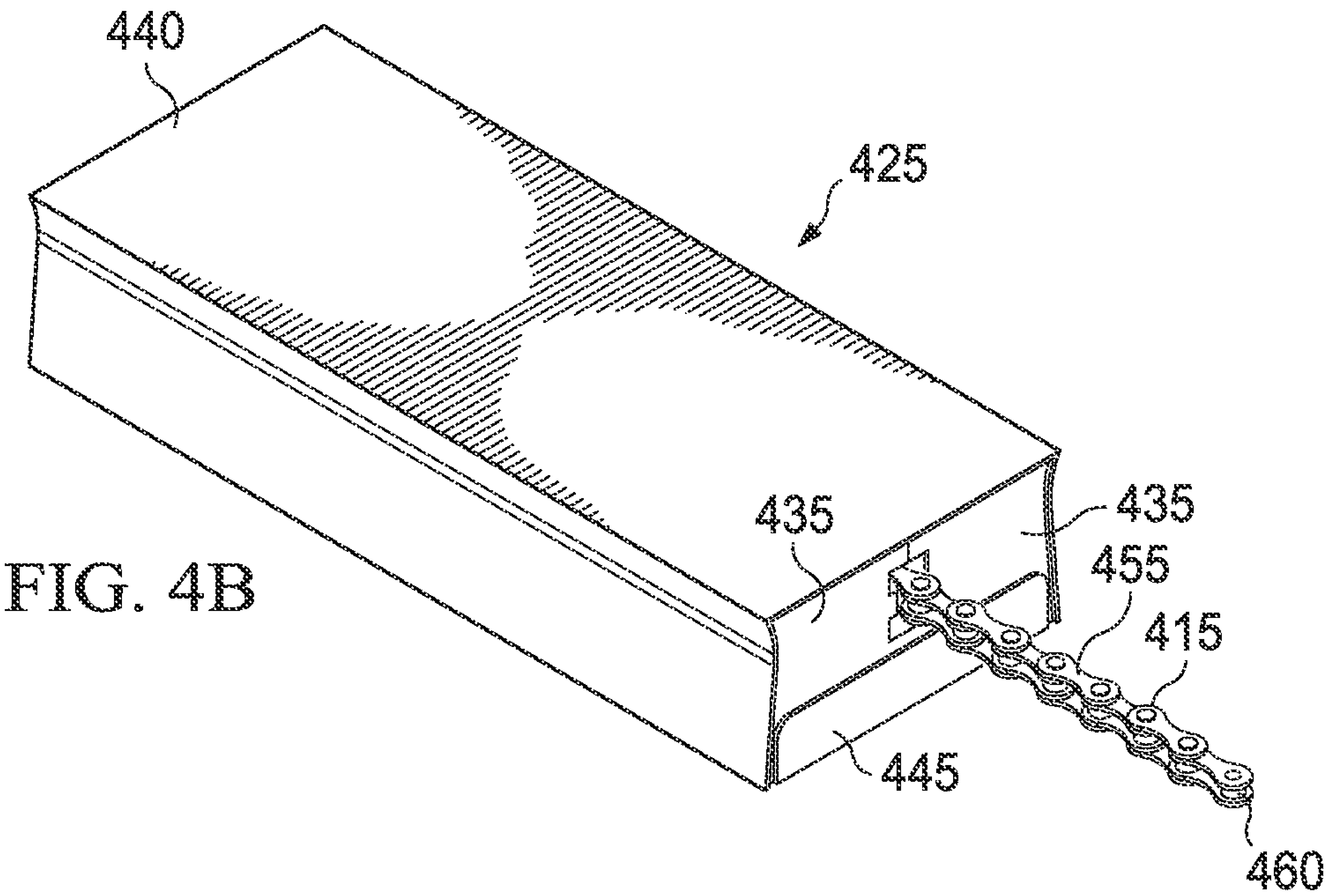
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FIG. 4B

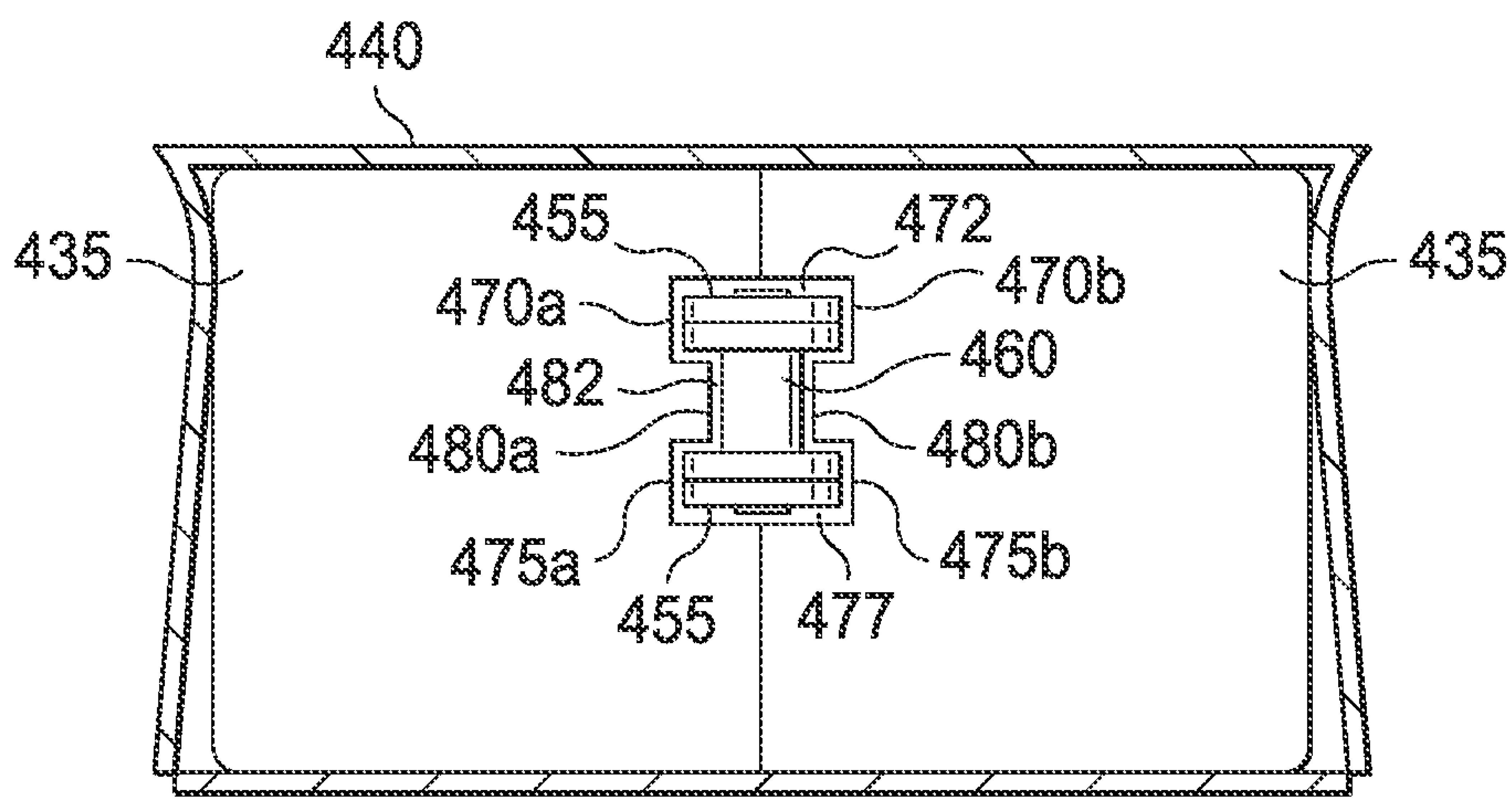
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FIG. 4C

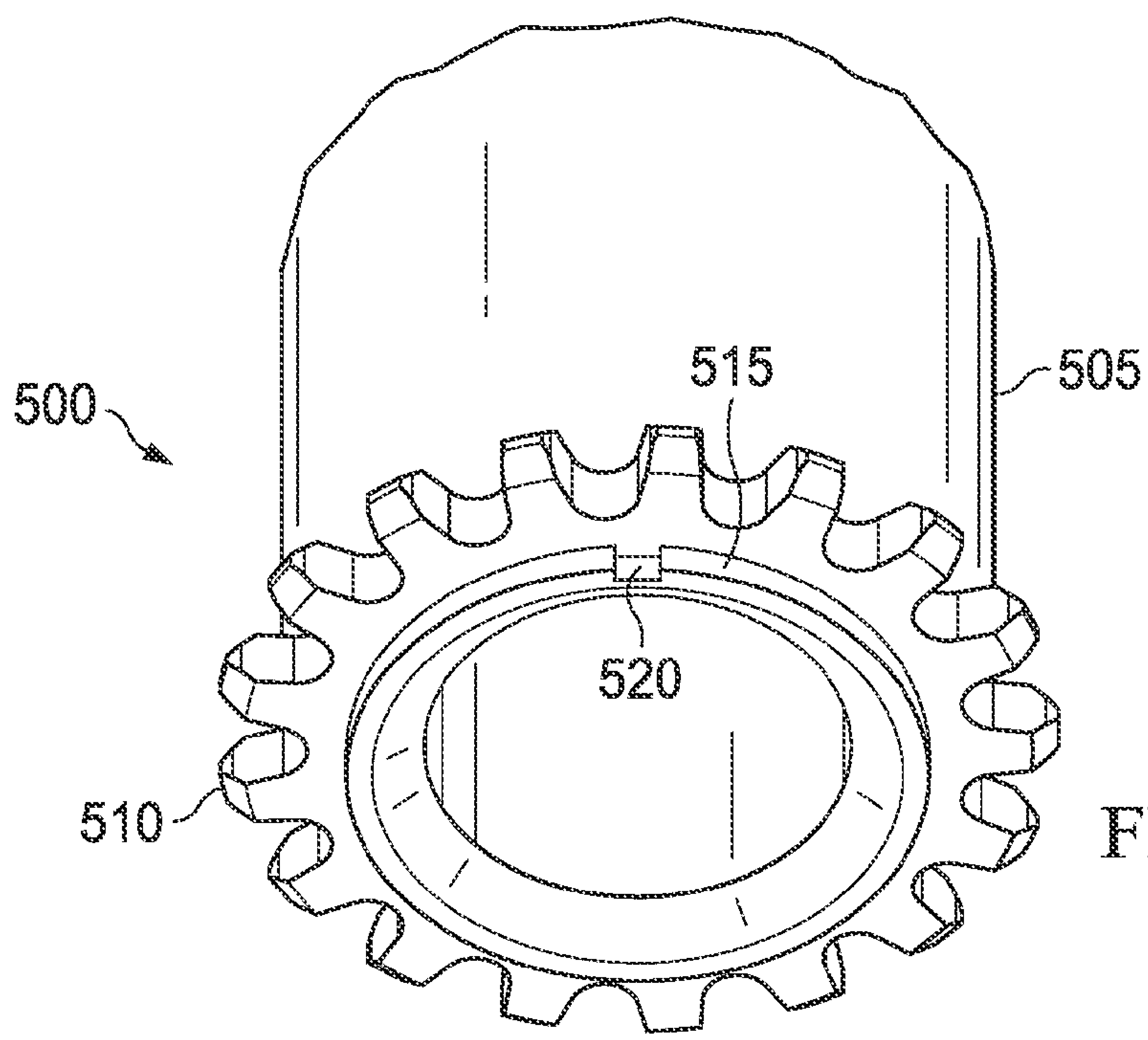


FIG. 5A

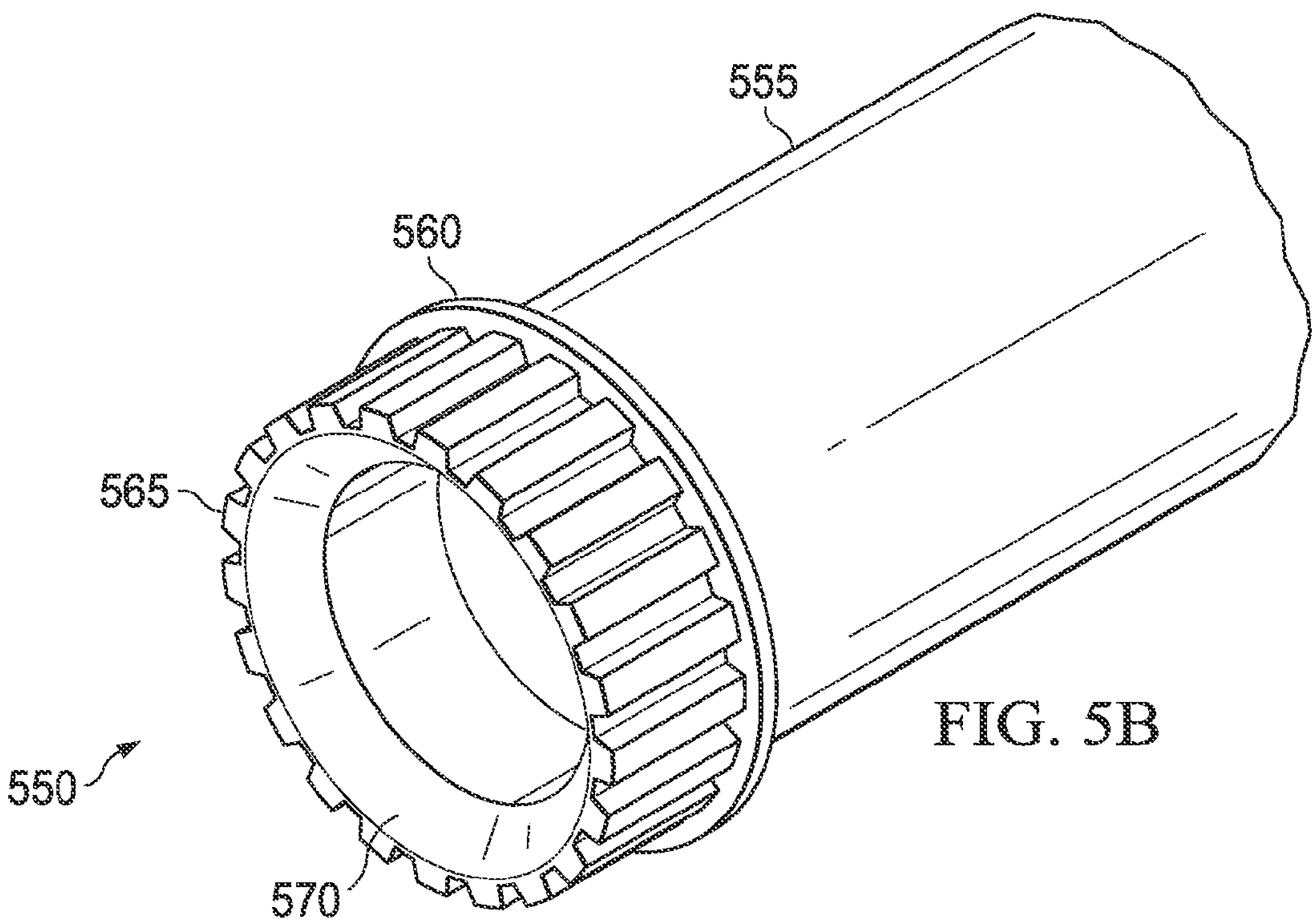


FIG. 5B

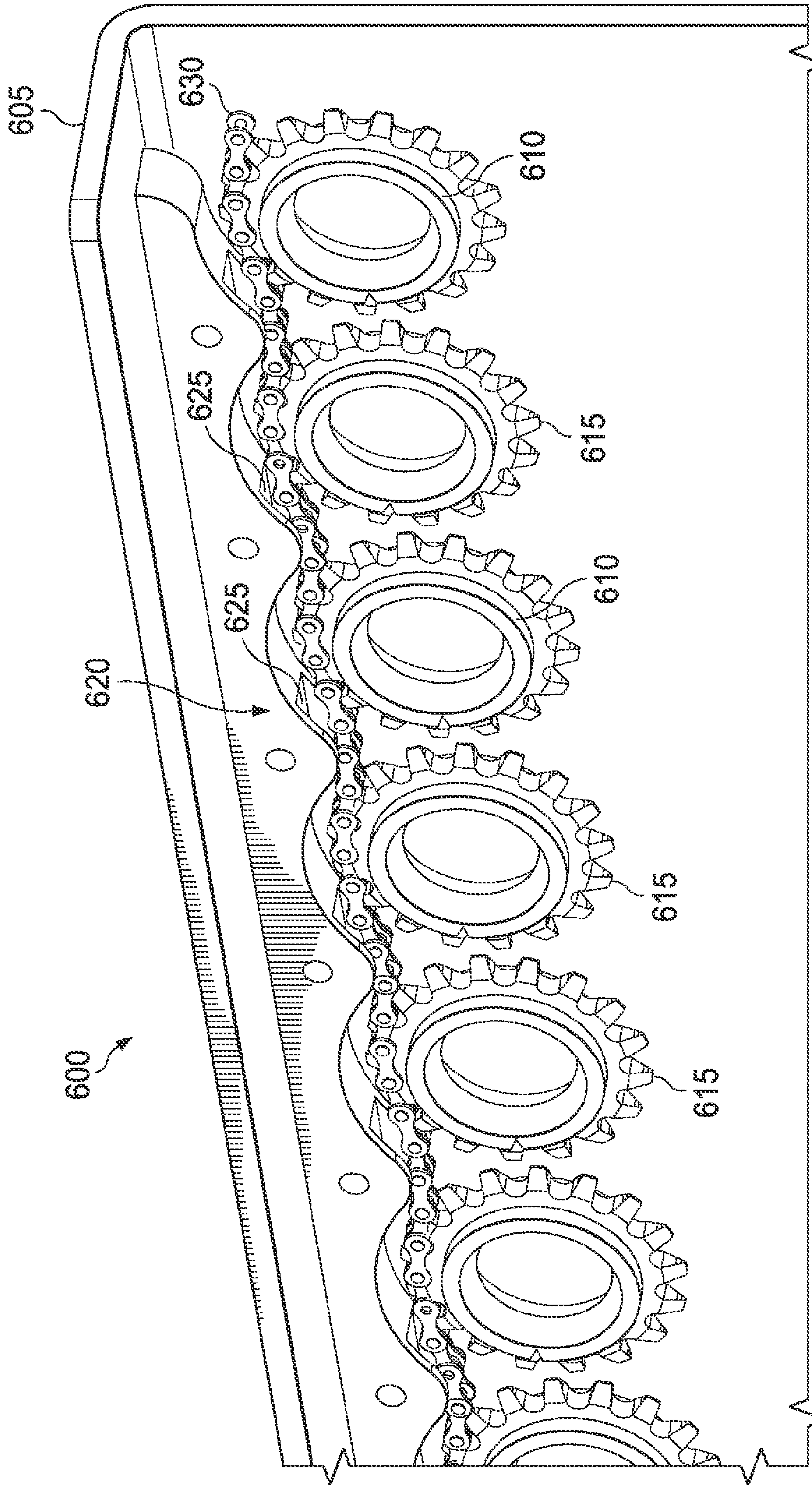


FIG. 6A

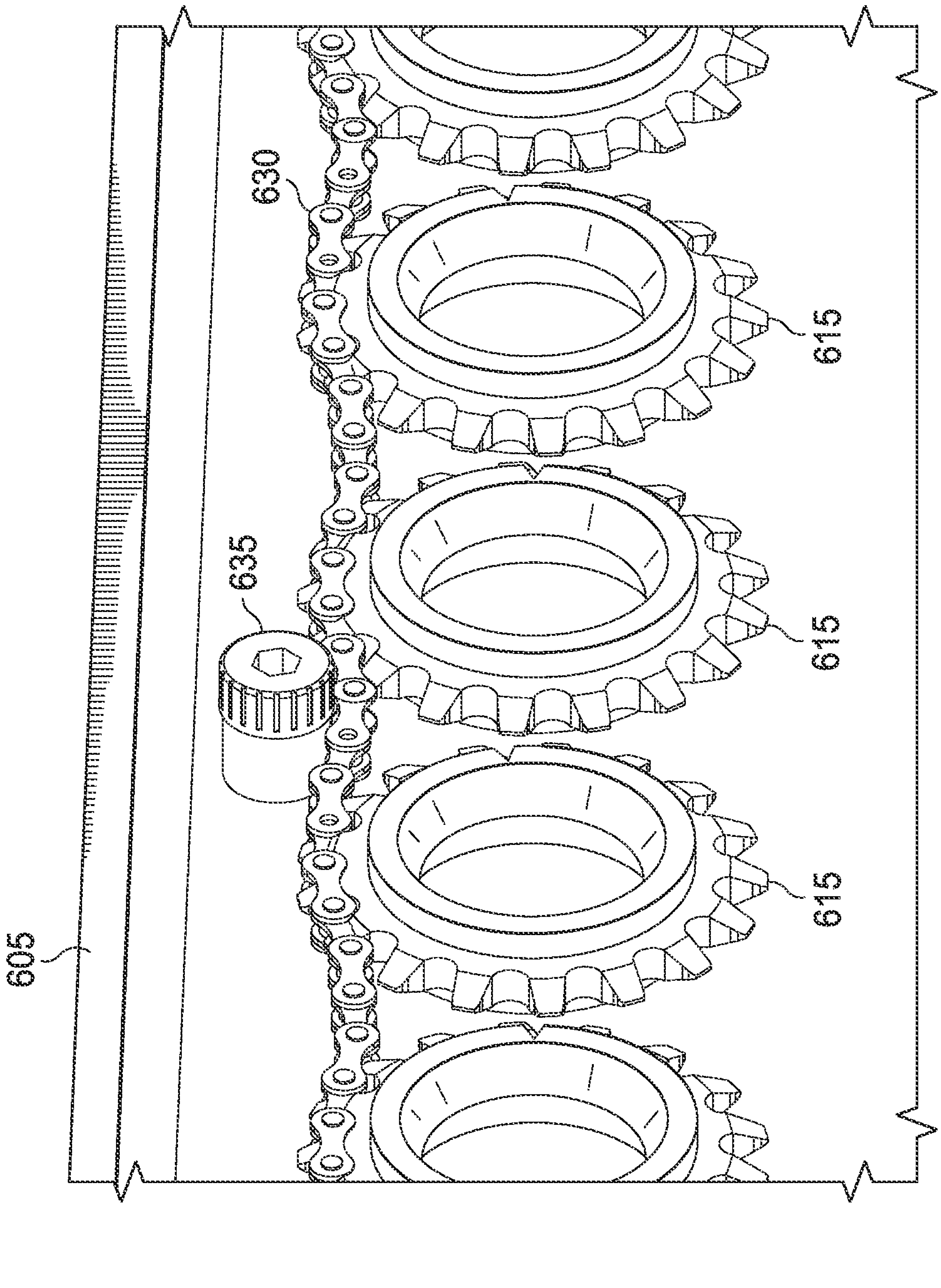


FIG. 6B

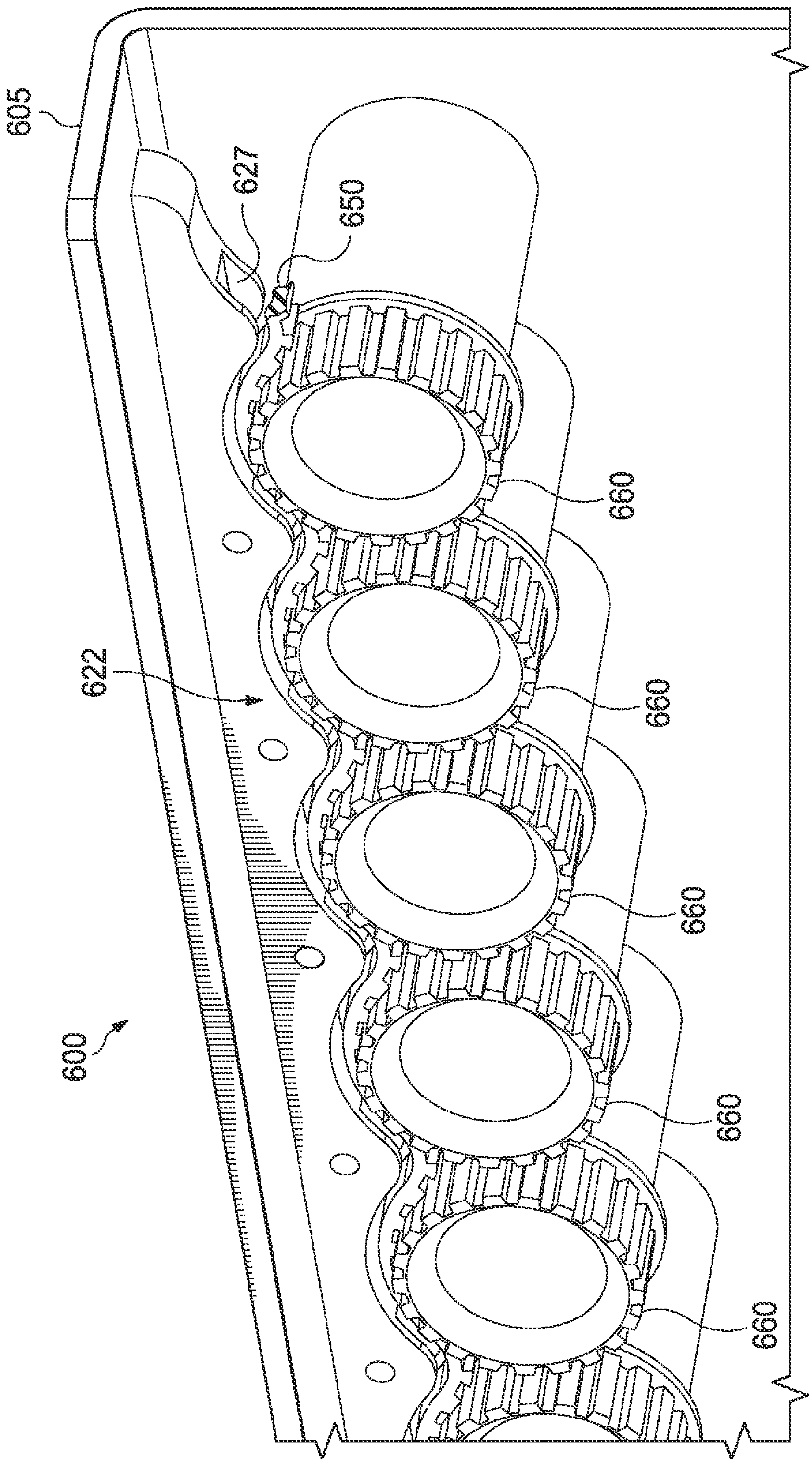


FIG. 6C

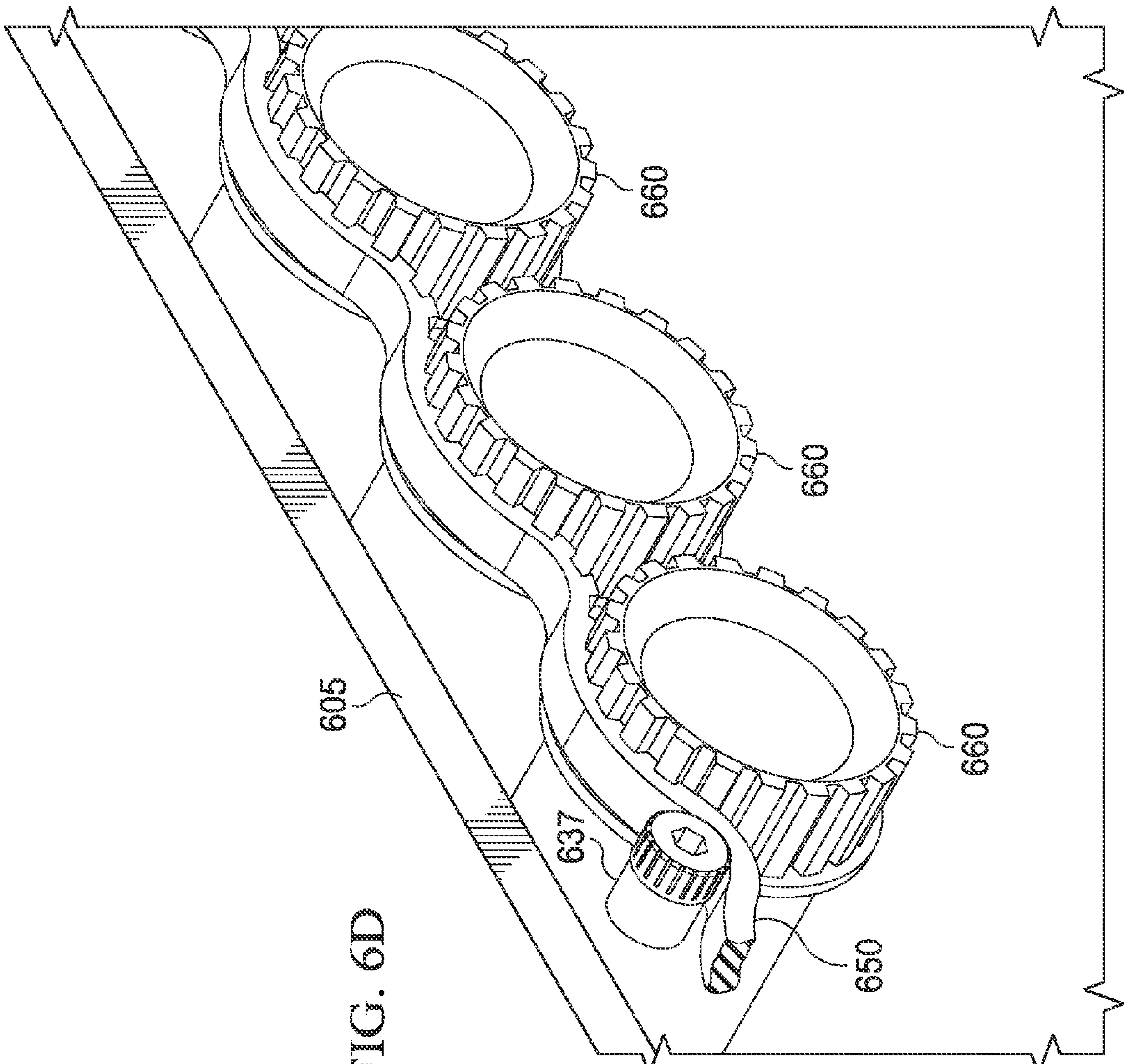
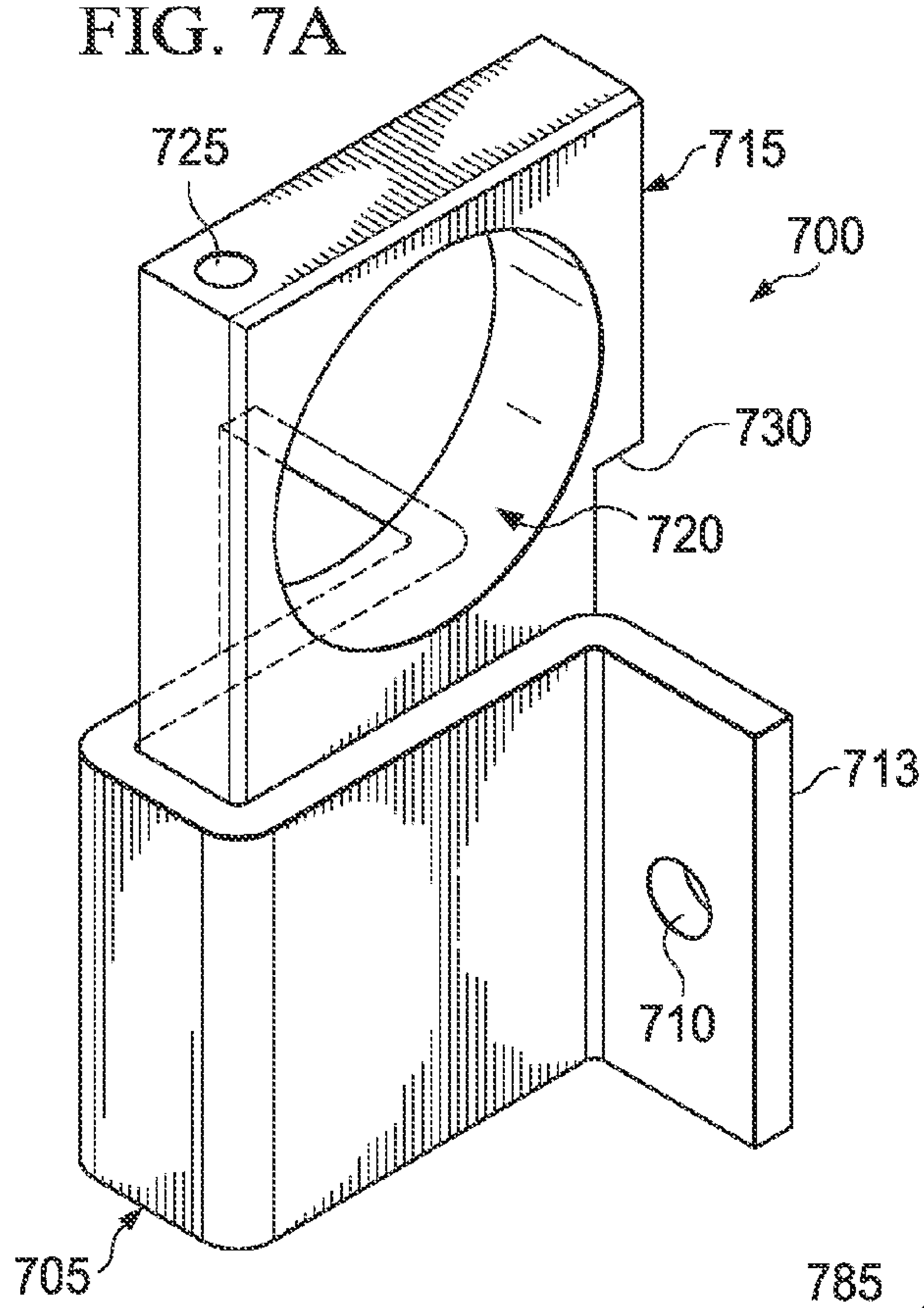


FIG. 6D

FIG. 7A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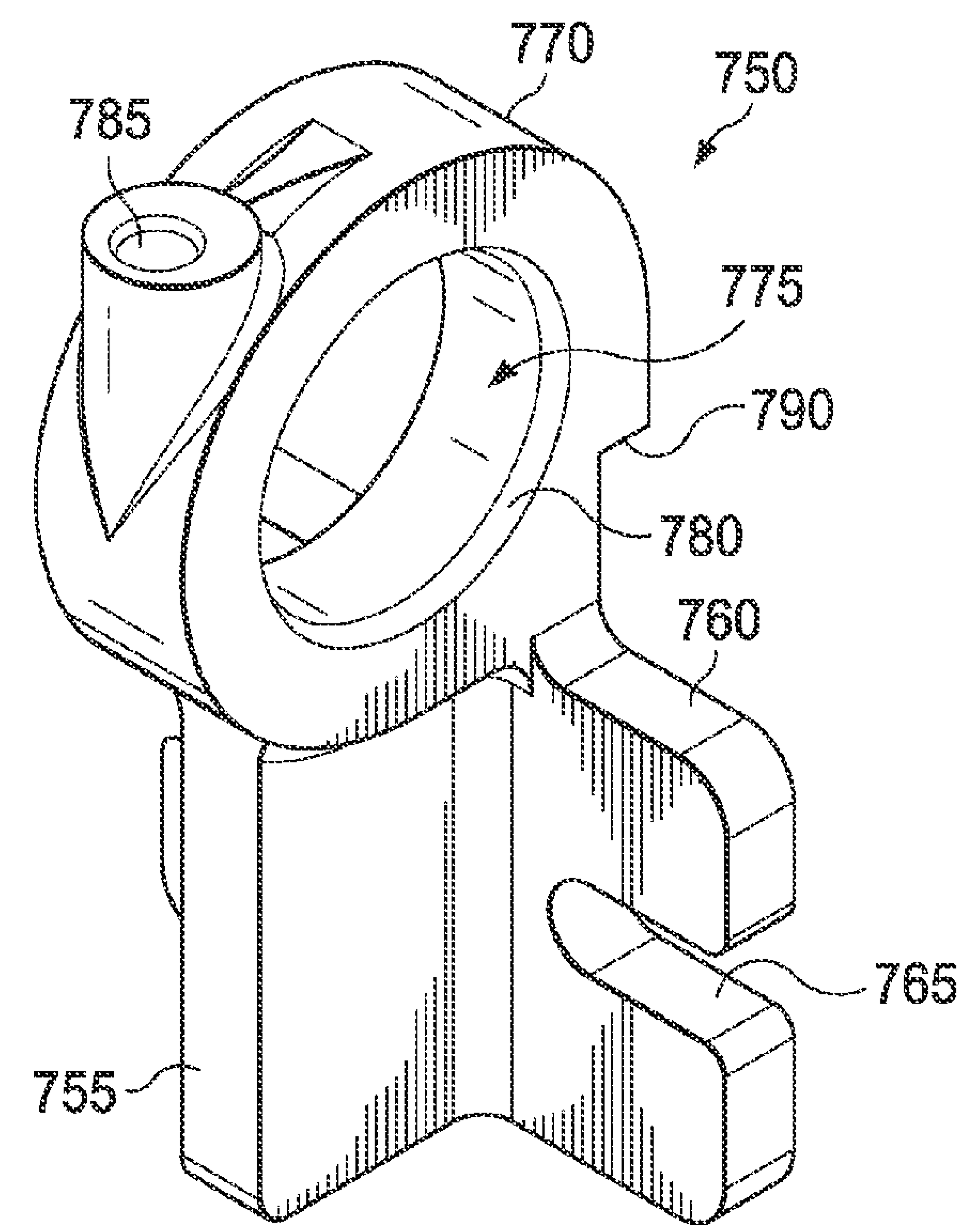
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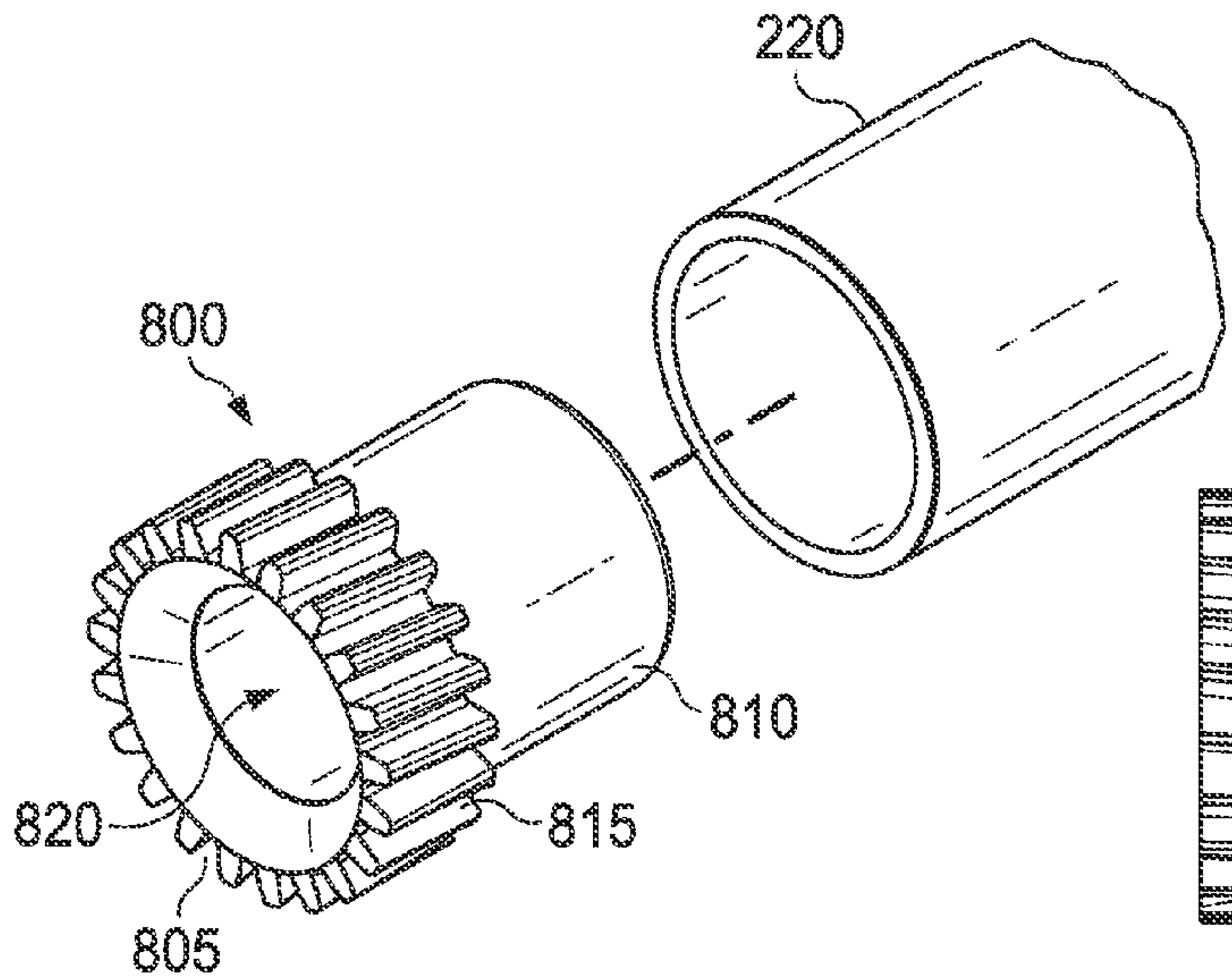
FIG. 7B



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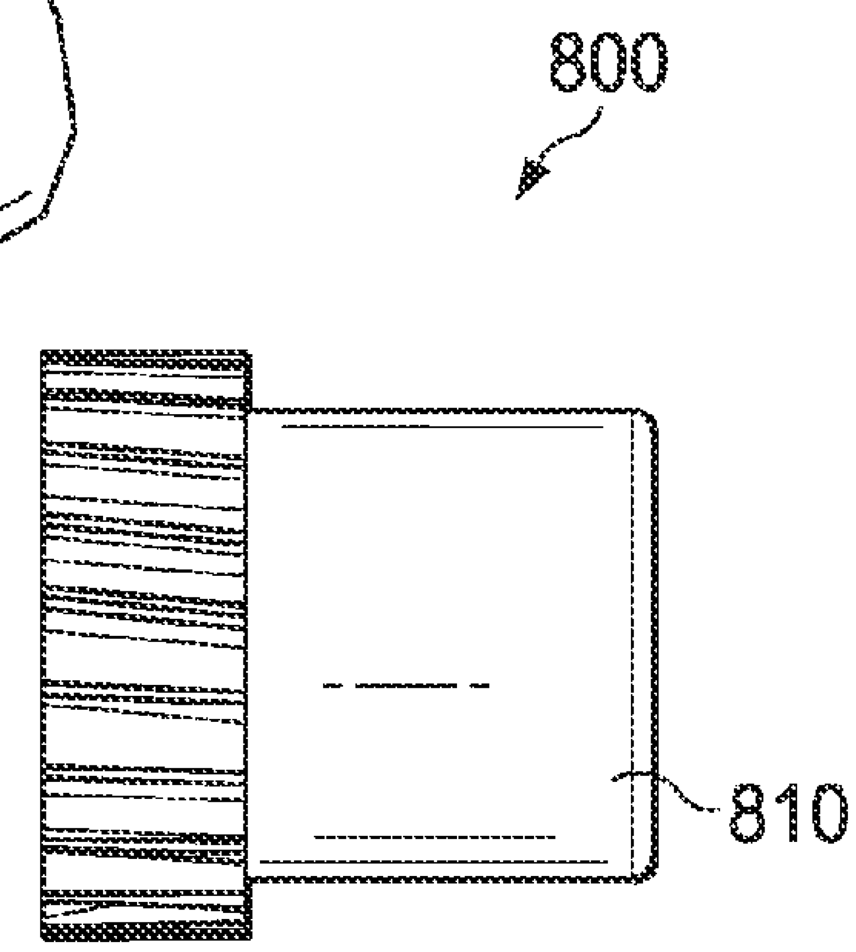

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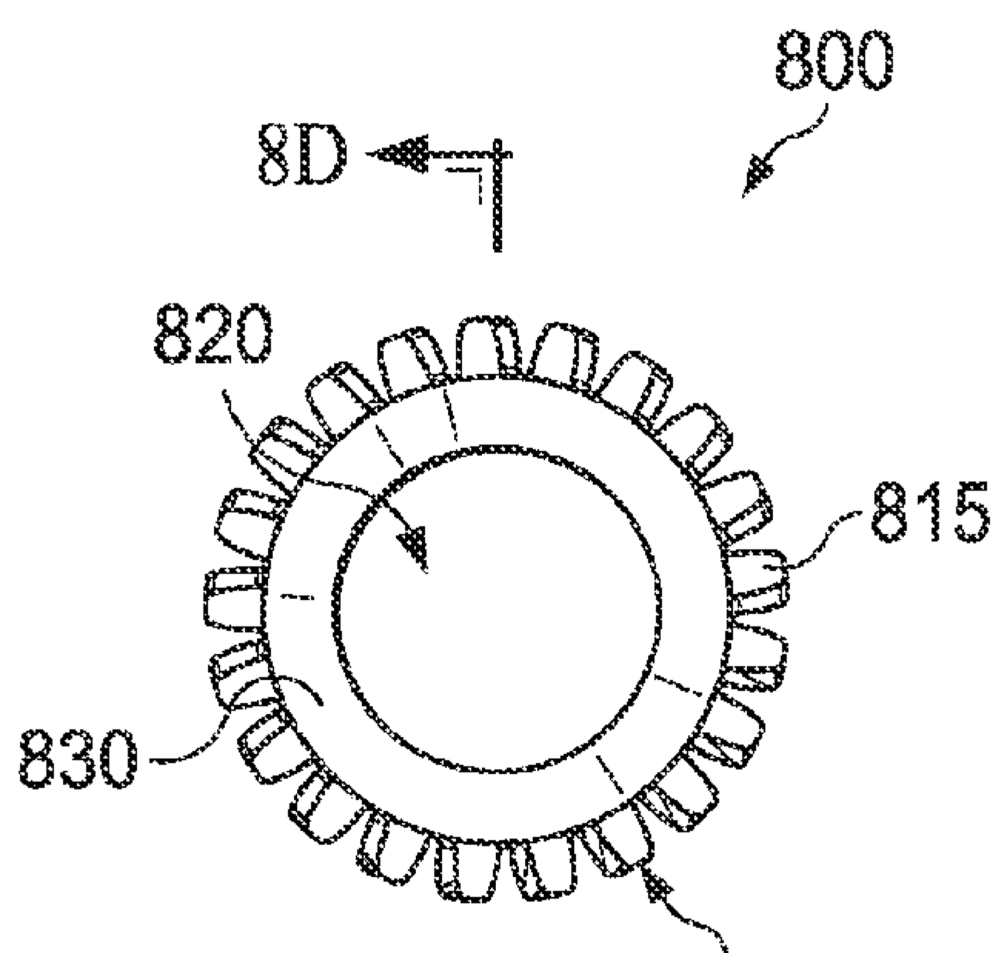

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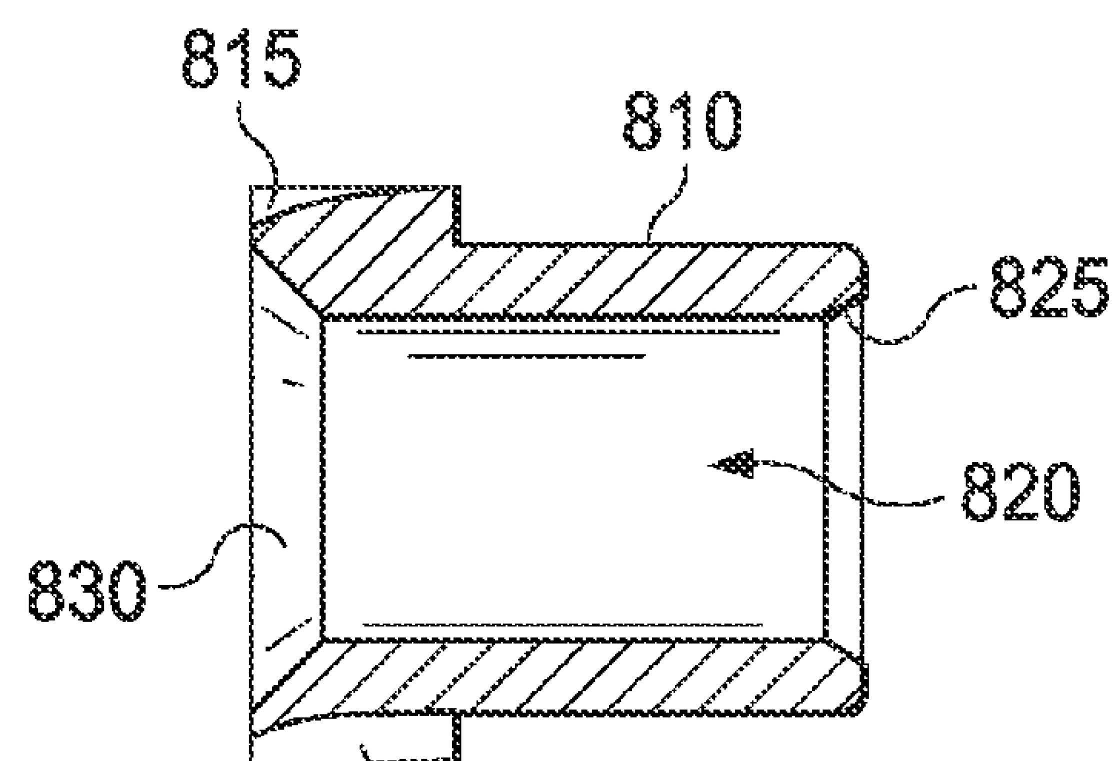


FIG. 8D

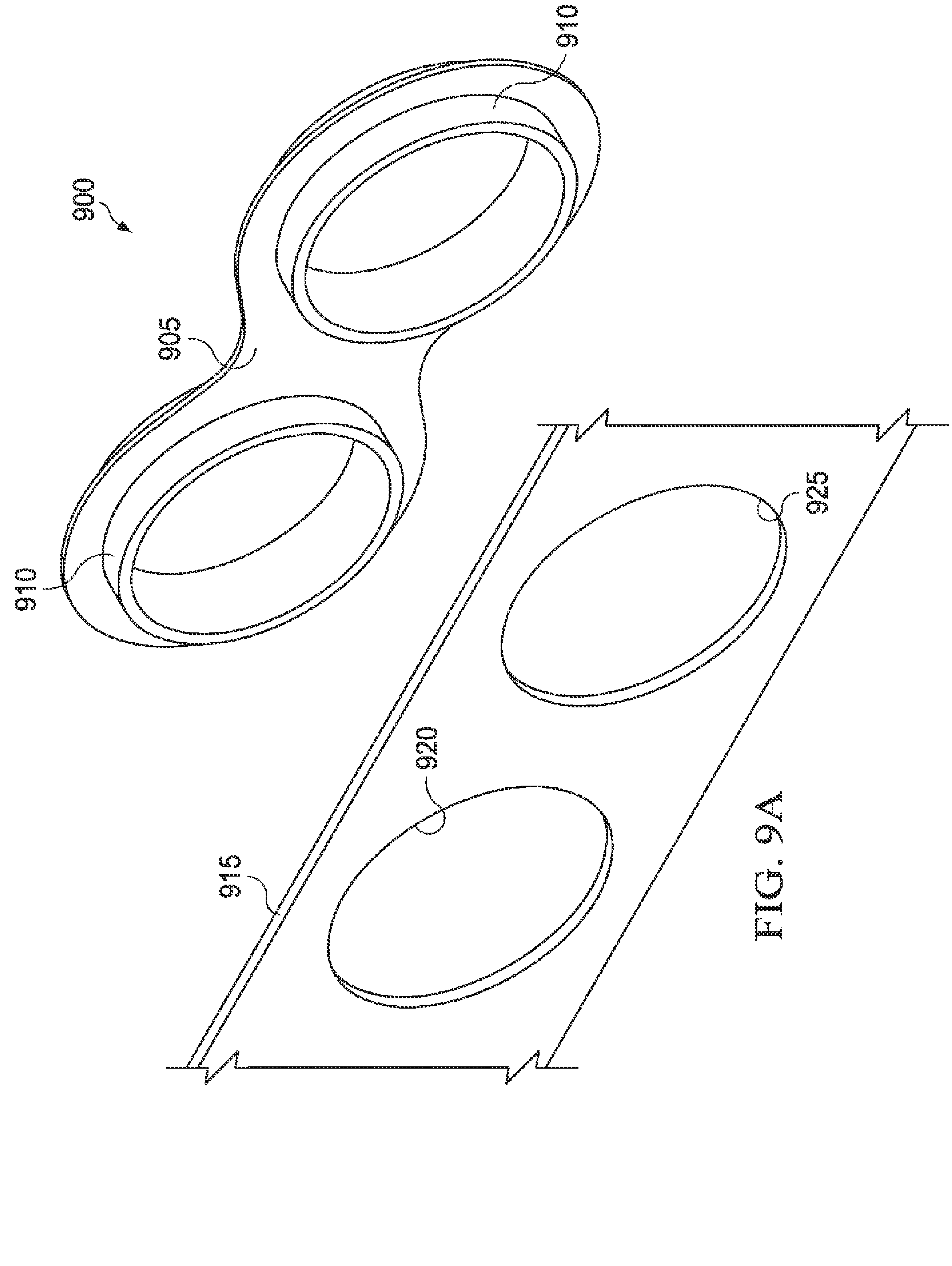
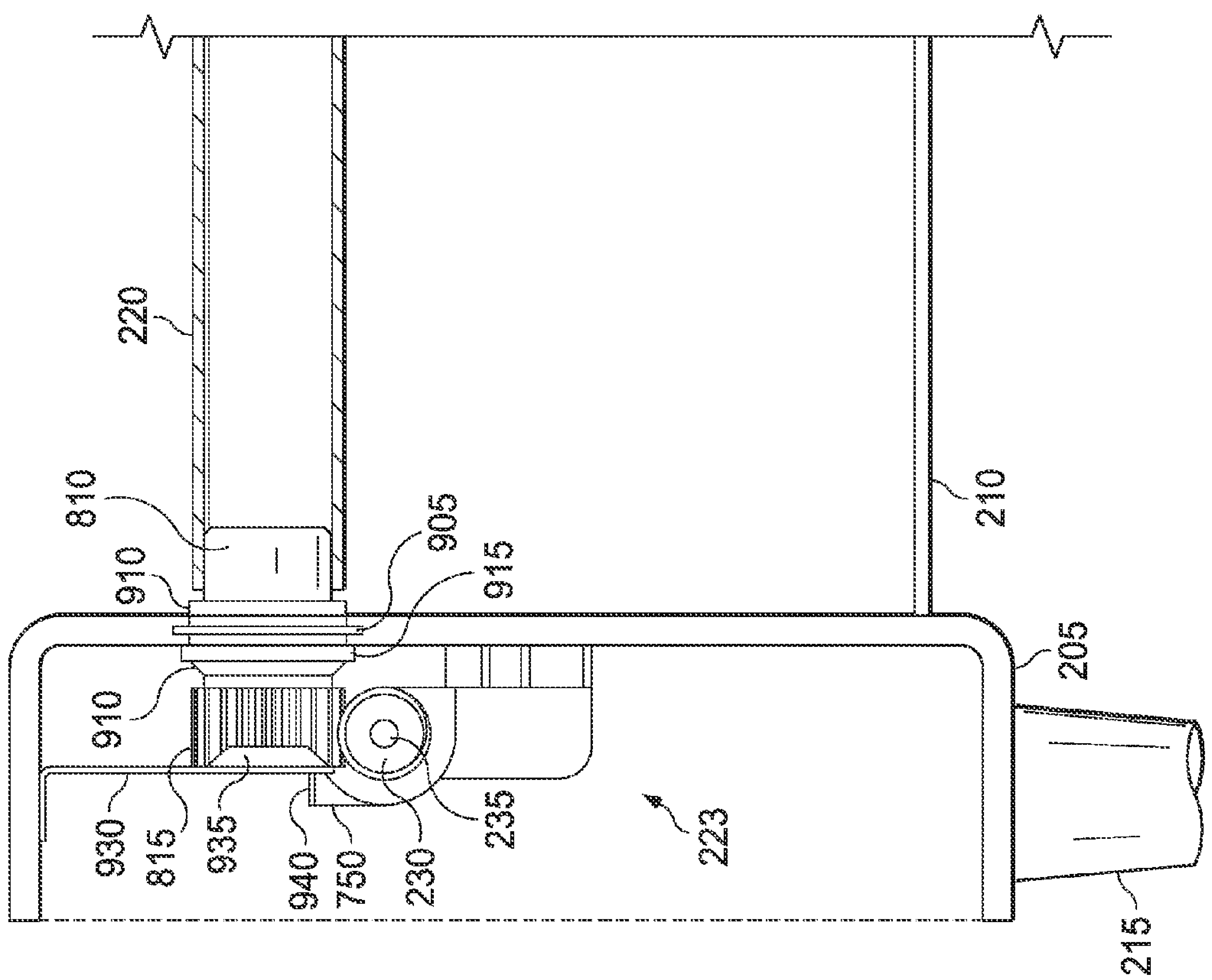


FIG. 9A

FIG. 9B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ROLLER GRILL

TECHNICAL BACKGROUND

This disclosure relates to a roller grill or griddle for heating and/or reheating pre-cooked food product.

BACKGROUND

Various apparatus are used to heat and/or reheat prepared consumer pre-cooked food products. In some instances, cylindrically shaped pre-cooked food products, such as hot-dogs, tacquitos, cheese burger bites, and sausage links, may be prepared using a roller grill apparatus, which may include a number of heated, rotating tubes upon which the pre-cooked food products rest and rotate. While the heat conducting and/or radiating from the tubes and the rotation of the tubes allow the pre-cooked food products to be heated substantially uniformly, these features can also impose detrimental effects on other components of the roller grill apparatus. For example, heat conducted and/or radiated from the ends of the tubes is transferred to rotating drive mechanism components in contact with the ends of the tubes, such as chains, lubricants, bearings, and other components. The heat conducted and/or radiated through these components, as well as the mechanical engagement of these components with one another during operation of the roller grill apparatus, can cause gradual deterioration and eventual failure of such components.

Conventionally, roller grills and/or griddles used for heating and/or reheating pre-cooked food products have used chain drive assemblies to drive (e.g., rotate) tubular heating surfaces on which the pre-cooked food products may be placed. The chain drive assemblies typically utilize a metallic chain that engages metallic sprockets mounted on the tubular heating surfaces. Due in part to the metal-on-metal contact, as well as the heat energy conducted through and/or radiated from the sprockets and chain from the tubular heating surfaces (and other components of conventional roller grills), the chain drive assembly may require regular maintenance (e.g., lubrication, adjustment of the chain and/or the sprockets to maintain suitable engagement, and otherwise). Without such regular maintenance, conventional roller grills often experience high failure rates.

In some instances, pre-cooked food products must be heated to a minimum internal temperature in order to, for example, kill bacteria that can cause food related illness. For instance, certain standards (e.g., NSF International) have been established that require pre-cooked food product to be heated to a minimum internal temperature for safety reasons.

SUMMARY

In one general embodiment, a roller grill for heating a pre-cooked food product includes a housing structure adapted to support the roller grill; a plurality of tubes having outer surfaces adapted to transfer heat to the pre-cooked food product; a plurality of rollers mounted in a row, each roller mounted on an end of a corresponding tube and including a plurality of detented projections extending from a circumferential surface of the roller; and a drive assembly. The drive assembly includes a motor including a shaft, the motor adapted to generate rotational power through the shaft at a first rotational speed; and a continuous looped surface coupled to the shaft and contactingly engaged with the detented projections of the plurality of rollers, the loop adapted to transfer the rotational power to the plurality of

gears at a second rotational speed. The roller grill further includes a protrusion mounted to the housing structure and in contacting engagement with the continuous looped surface, such that the continuous looped surface is contactingly engaged with at least two detented projections of each roller of the plurality of rollers mounted in the row.

In a first aspect combinable with the general embodiment, the first and second rotational speeds are substantially identical.

In a second aspect combinable with any of the previous aspects, the continuous looped surface includes a chain, and the plurality of rollers include a plurality of sprockets.

In a third aspect combinable with any of the previous aspects, the plurality of detented projections include a plurality of teeth extending from respective circumferential surfaces of the plurality of sprockets.

In a fourth aspect combinable with any of the previous aspects, the chain is contactingly engaged with the plurality of teeth.

In a fifth aspect combinable with any of the previous aspects, the chain is contactingly engaged with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

In a sixth aspect combinable with any of the previous aspects, the protrusion mounted to the housing structure includes a chain guide having a serpentine surface contactingly guiding the chain into contacting engagement with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

In a seventh aspect combinable with any of the previous aspects, the serpentine surface includes alternating peaked portions and recessed portions, and the chain is in contacting engagement with the peaked portions.

In an eighth aspect combinable with any of the previous aspects, the peaked portions are arranged between adjacent sprockets of the plurality of sprockets in the row.

In a ninth aspect combinable with any of the previous aspects, the protrusion mounted to the housing structure includes a guide roller adapted to rotate about an axis, and the guide roller contactingly guides the chain into contacting engagement with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

In a tenth aspect combinable with any of the previous aspects, the guide roller is mounted to the housing structure between adjacent sprockets of the plurality of sprockets in the row.

In an eleventh aspect combinable with any of the previous aspects, the continuous looped surface incudes a timing belt, and the plurality of rollers include a plurality of timing pulleys.

In a twelfth aspect combinable with any of the previous aspects, the timing belt includes a plurality of teeth protruding from a surface of the timing belt, the teeth engageable with a plurality of corresponding teeth disposed on circumferential surfaces of the plurality of timing pulleys.

In a thirteenth aspect combinable with any of the previous aspects, the timing belt is contactingly engaged with at least two teeth of each timing pulley of the plurality of timing pulleys mounted in the row.

In a fourteenth aspect combinable with any of the previous aspects, the protrusion mounted to the housing structure includes a belt guide having a serpentine surface contactingly guiding the timing belt into contacting engagement with at least two teeth of each timing pulley of the plurality of timing pulleys mounted in the row.

In a fifteenth aspect combinable with any of the previous aspects, the serpentine surface includes alternating peaked

portions and recessed portions, and the timing belt is in contacting engagement with the peaked portions.

In a sixteenth aspect combinable with any of the previous aspects, the peaked portions are arranged between adjacent timing pulleys of the plurality of timing pulleys in the row.

In a seventeenth aspect combinable with any of the previous aspects, the protrusion mounted to the housing structure includes a guide roller adapted to rotate about an axis, and the guide roller contactingly guides the timing belt into contacting engagement with at least two teeth of each timing pulley of the plurality of timing pulleys mounted in the row.

In an eighteenth aspect combinable with any of the previous aspects, the guide roller is mounted to the housing structure between adjacent timing pulleys of the plurality of timing pulleys in the row.

In another general embodiment, an apparatus for heating a pre-cooked food product includes a housing structure adapted to support the apparatus; a plurality of tubes having outer surfaces adapted to transfer heat to the pre-cooked food product; a motor including a shaft, the motor adapted to generate rotational power through the shaft at a first rotational speed; means, mounted to corresponding ends of the plurality of tubes, for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes; means, coupled to the shaft, for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes; and means, in contact with the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes, for urging the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes into contacting engagement with the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes.

In a first aspect combinable with the general embodiment, the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes is one of a chain or timing belt.

In a second aspect combinable with any of the previous aspects, the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes include a plurality of sprockets, each sprocket having a plurality of teeth extending from respective circumferential surfaces of the plurality of sprockets, and the chain is contactingly engaged with the plurality of teeth.

In a third aspect combinable with any of the previous aspects, the chain is contactingly engaged with at least two teeth of each sprocket of the plurality of sprockets.

In a fourth aspect combinable with any of the previous aspects, the means for urging the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes into contacting engagement with the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes comprises one of a chain guide or a guide roller.

In a fifth aspect combinable with any of the previous aspects, the chain guide includes a serpentine surface contactingly guiding the chain into contacting engagement with at least two teeth of each sprocket of the plurality of sprockets.

In a sixth aspect combinable with any of the previous aspects, the peaked portions are arranged between adjacent sprockets of the plurality of sprockets.

In a seventh aspect combinable with any of the previous aspects, the guide roller contactingly guides the chain into contacting engagement with at least two teeth of each sprocket of the plurality of sprockets.

In an eighth aspect combinable with any of the previous aspects, the guide roller is mounted to the housing structure between adjacent sprockets of the plurality of sprockets.

In a ninth aspect combinable with any of the previous aspects, the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes comprise a plurality of timing pulleys.

In a tenth aspect combinable with any of the previous aspects, the timing belt is contactingly engaged with at least two teeth of each timing pulley of the plurality of timing pulleys.

In an eleventh aspect combinable with any of the previous aspects, the means for urging the means for transferring the generated rotational power from the motor to the means mounted to corresponding ends of the plurality of tubes into contacting engagement with the means for receiving the generated rotational power and transferring the generated rotational power to the plurality of tubes comprises one of a belt guide or a guide roller.

In a twelfth aspect combinable with any of the previous aspects, the belt guide includes a serpentine surface contactingly guiding the timing belt into contacting engagement with at least two teeth of each timing pulley of the plurality of timing pulleys.

In a thirteenth aspect combinable with any of the previous aspects, the serpentine surface includes alternating peaked portions and recessed portions, and a substantially smooth surface of the timing belt is in contacting engagement with the peaked portions.

In a fourteenth aspect combinable with any of the previous aspects, the peaked portions are arranged between adjacent timing pulleys of the plurality of timing pulleys.

In a fifteenth aspect combinable with any of the previous aspects, the guide roller is mounted to the housing structure between adjacent timing pulleys of the plurality of timing pulleys.

Various embodiments of a roller grill according to the present disclosure may include one or more of the following features. For example, the roller grill may operate in one or more selectable heating and/or reheating modes, such as a "Preparation" mode or a "Ready-to-Serve" mode. In some embodiments, the roller grill can include one or more of a cover plate and a plenum plate that serve as heat sinks by absorbing heat radiating from roller grill heating tubes and/or from drive assembly components included within the roller grill.

Various embodiments of a roller grill according to the present disclosure may also include one or more of the following features. For example, the roller grill may include a lubricator designed to clean and lubricate a drive chain included within the roller grill, such that an appropriate amount of lubricant is provided to the drive chain during operation of the roller grill. Furthermore, the lubricator may be used with any chain-driven system that needs regular lubrication maintenance, such as a bicycle chain. In some embodiments, the roller grill may have a chain glide that causes the drive chain of the roller grill to engage more than one tooth of sprockets (e.g., sprockets located between end sprockets) included within the roller grill. This multiple tooth engagement may reduce the probability of the chain being displaced from the sprockets and reducing the frictional wear on the chain and on the sprockets. In some examples, the roller grill can include rollers that increase the engagement of the drive chain with teeth on more than one sprocket at the same time.

Various embodiments of a roller grill according to the present disclosure may also include one or more of the following features. For example, the roller grill may utilize a belt drive assembly coupled to a worm gear assembly (e.g., a screw worm gear assembly) to rotate one or more heating tubes. In some examples, the cooling cycle can extend the life of the timing belt and/or provide the timing belt with a longer life as compared to a drive chain. In some examples, the cooling cycle can drop the temperature of the timing belt by up to 50° F. (10° C.). In some embodiments, the cooling cycle may provide the timing belt with a life of up to six years. In some embodiments, the roller grill may utilize a direct drive assembly, thereby eliminating belts and chains.

These general and specific embodiments may be implemented using a device, system or method, or any combinations of devices, systems, or methods. The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIGS. **1**A-**1**E illustrate views of an example embodiment of a roller grill utilizing a direct drive assembly in accordance with the present disclosure;

FIGS. **2**A-**2**D illustrate views of an example embodiment of a roller grill including a belt drive assembly including one or more worm gears in accordance with the present embodiments;

FIGS. **3**A-**3**B illustrate views of another example embodiment of a roller grill utilizing a belt drive assembly in accordance with the present disclosure;

FIGS. **4**A-**4**C illustrate views of another example embodiment of a roller grill utilizing a chain drive assembly in accordance with the present disclosure;

FIGS. **5**A-**5**B illustrate views of example embodiments of a roller grill tube in accordance with the present disclosure;

FIGS. **6**A-**6**D illustrate views of example embodiments of a roller grill having a chain drive assembly or a belt drive assembly according to the present disclosure;

FIGS. **7**A-**7**B illustrate example embodiments of a bearing block that may be used to support a rotating shaft of a roller grill according to the present disclosure;

FIGS. **8**A-**8**D illustrate an example worm gear that may be used in a roller grill according to the present disclosure; and

FIGS. **9**A-**9**B illustrates an example bushing plate that may be used in a roller.

DETAILED DESCRIPTION

This disclosure relates to apparatus for heating and/or reheating prepared consumer pre-cooked food products, and more particularly, to roller grills and/or griddles used for heating and/or reheating cylindrically shaped pre-cooked food products, such as hotdogs and sausage links. Although in some embodiments, a roller grill according to the present disclosure may only heat and/or reheat a pre-cooked food product, in other embodiments, a roller grill according to the present disclosure may cook a raw food product.

In a general embodiment, a roller grill includes two side housings, a bottom housing, and multiple heating tubes that are disposed parallel to one another, across a volume defined between upper regions of opposite panels of the two side housings, and above the bottom housing. The heating tubes are positioned sufficiently close to one another, such that their positioning allows a pre-cooked food product to simultaneously rest atop two adjacent heating tubes. The heating tubes are further designed to rotate 360 degrees and have outer surfaces that are adapted to transfer heat to pre-cooked food products, thereby allowing the heating tubes to heat and/or reheat pre-cooked food products that rest atop the heating tubes.

In some embodiments, the roller grill may include a belt drive assembly having worm gears that provides rotary motion to the heating tubes. For example, the belt drive assembly can be driven by a motor that provides rotary motion to a timing belt that transfers the motion to a timing pulley, which further rotates a shaft on which worm gears are mounted and engage spur gears that are coupled to ends of the heating tubes. In some embodiments, the belt drive assembly can have timing pulleys coupled to the ends of the heating tubes and multiple idler pulleys that provide alternating heating and cooling cycles, respectively, for the timing belt during operation of the roller grill. In some examples, the timing pulleys can be maintained on the ends of the heating tubes by TEFLON™ flanges.

In some embodiments, the roller grill may include a chain drive assembly having sprockets that provides rotary motion to the heating tubes. For example, the chain drive assembly can be driven by a motor that provides rotary motion to a chain, which transfers the motion to sprockets coupled to the ends of the heating tubes. In some embodiments, the roller grill can further include a lubricator that surrounds the chain and cleans and lubricates and cools the chain substantially constantly such that an appropriate amount of lubricant is provided to the chain. In some embodiments, the roller grill can include one or both of a chain glide or multiple rollers that cause the chain to simultaneously engage more than one tooth of the sprockets, which may reduce the wear on one or both of the chain or the sprockets.

In some embodiments, the roller grill may have a direct drive assembly including a drive gear coupled to a motor and in engagement with one or more transfer gears configured to transfer rotational motion of the drive gear to matched sets of gears directly coupled to heating tubes. The gears may, in some embodiments, be spur gears. In some embodiments, the gears may be helical spur gears. In some embodiments, the gears may be non-metallic, such as, for example, a high-temperature plastic. In some embodiments, for example, one or more gears directly coupled to heating tubes may be a high-temperature plastic such as, for example, polystyrene, nylon, TEFLON™, polyethylene, polypropylene, polyvinyl chloride and polytetrafluoroethylene (PTFE), and other plastic material) that has a continual duty max temperature rating of between about 250° F. (121° C.) and about 500° F. (260° C.). In some embodiments, for example, one or more transfer and/or idler gears may be a high-temperature plastic that has a continual duty max temperature rating of between about 120° F. (49° C.) and about 200° F. (93° C.).

FIGS. **1**A-**1**E illustrate views of an example embodiment of a roller grill **100** utilizing a direct drive assembly for heating and/or reheating pre-cooked food products, such as, for example, cylindrically shaped pre-cooked food products including hotdogs, sausage links, and other products. With reference to FIG. **1**A in particular, the roller grill **100** includes two side housings **105***a* and **105***b* and a bottom housing **110** that is attached to and disposed between lower regions of panels of the two side housings **105***a* and **105***b*. The weight of the roller grill **100** is supported by multiple legs **115** that are mounted underneath and near corners of the bottom housing **110**. The roller grill **100** further includes multiple heating tubes **120** that are disposed parallel to one another, across a volume defined between upper regions of opposite panels of the two side housings **105***a* and **105***b*, and above the bottom housing **110**. The heating tubes **120** are positioned sufficiently close to one another, such that their positioning allows a pre-cooked food product **125** to simultaneously rest atop two adjacent heating tubes **120**. One or more annular shaped dividers **130** may be mounted on one or more heating tubes **120** in order to prevent contact between two pre-cooked food products **125** resting atop common heating tubes **120** or to restrict lateral movement of pre-cooked food products **125** resting atop the heating tubes **120**.

In some embodiments, the roller grill **100** may be approximately 36 inches (91 cm) in total length, and the heating tubes **120** may be approximately 35.625 inches (90.488 cm) in length. In some examples, the wall thickness of a heating tube may be between approximately 5/64 inches (0.20 cm) and approximately 1/8 inches (0.32 cm). In some examples, the width of the roller grill **100** may depend on the number of heating tubes **120** included within the roller grill **100**. In some examples, the roller grill **100** can include multiple (e.g., 4, 8, 16, or other number) heating tubes **120**.

In some embodiments, the heating tubes **120** have outer surfaces that are adapted to transfer heat to pre-cooked food products **125** (e.g., non-stick surfaces, cleanable surfaces, or otherwise). The heating tubes **120**, in some embodiments, are further designed to rotate 360 degrees, which consequently rotates the pre-cooked food products **125** 360 degrees that are in contact with the heating tubes **120**. The heating tubes **120** may be heated by multiple electric resistive heat elements. In some embodiments, at least one of the electric resistive heat elements may be disposed within a bore of at least one of the heating tubes **120**. In some examples, the heat conducted to the surfaces of the heating tubes **120** allows them to heat/and or reheat the pre-cooked food products **125**. In some instances, the electric resistive heat elements can enable the surface temperatures of the heating tubes **120** to reach up to 300° F. (149° C.). In any event, the heating tubes **120** can heat the pre-cooked food products **125** to an internal temperature of about 160° F. (71° C.), or other temperature, to ensure that any bacteria is killed and/or eliminated.

As illustrated, the roller grill **100** may also include a drip plate **180** extending between the side housings **105***a* and **105***b* and underneath the heating tubes **120**. In some embodiments, the drip plate **180** may define a bottom side of a volume extending from directly underneath the heating tubes **120** to the drip plate **180** and between the side housings **105***a* and **105***b*. Such a volume, in some embodiments, may define a sanitary volume into which no mechanical components of the roller grill **100** (e.g., gears, motors, shafts, and other components) may extend. The drip plate **180** may, in some embodiments, be a cleanable surface that catches drippings and other solids and/or liquids from the pre-cooked food product **125**.

In some embodiments, the roller grill **100** can include a controller (not shown) that sets the roller grill **100** to operate in one or more heating modes. For example, the heating modes may include a "Preparation" mode that heats pre-cooked food products **125** to a set minimum preparation temperature (e.g., 160° F. (71° C.) internal) or a "Ready-to-Serve" mode that maintains the internal temperature of the pre-cooked food products **125** at a set serving temperature by cycling the heat on and off. In some examples, the preparation temperature of the heating tubes **120** may reach up to 300° F. (149° C.). In some examples, the serving temperature of the heating tubes **120** may reach up to 240° F. (116° C.) in order to maintain an internal pre-cooked food product temperature in the range of 140-160° F. (60-71° C.). The roller grill **100** can further be designed to operate in other heating modes (e.g., a timed heating mode, an overnight heating mode, a "wake up" heating mode, and others).

Turning to FIGS. **1**B-**1**E, top, end, and side views of a portion of the roller grill **100** utilizing a direct drive assembly are illustrated. As illustrated, the roller grill **100** includes a plenums **102***a* and **102***b* enclosed within the side housings **105***a* and **105***b* in which the direct drive assembly may be disposed. The direct drive assembly may drive (e.g., rotate) the heating tubes **120** to heat and/or reheat pre-cooked food product. As illustrated, each heating tube **120** is installed over a tubular portion of a heating tube gear **140**, which in turn, is installed through apertures in the side housing **105**. A bushing **135***a* may also be installed through the aperture of the side housing **105** such that the heating tube **120** is disposed within the bushing **135***a* and may move (e.g., rotate) within the bushing **135***a*. In some embodiments, as illustrated in FIG. **9**A, the bushing **135***a* may be a paired bushing, such that two heating tubes **120** are inserted through a single bushing **135***a*.

In the illustrated embodiment, a plenum plate **155** may be installed in the plenum **102***a* and to a surface of the side housing **105**. As illustrated, the plenum plate **155** may extend substantially an entire width of the plenum **102***a* (as shown in FIG. **1**C) and from a bottom edge of the plenum **102***a* to just above a midpoint of one or more idler gears **145**. In some embodiments, the idler gears **145**, as well as one or more transfer gears **160**, may be mounted to the plenum plate **155**. For instance, the gears **145** and **160** may be mounted through a mechanical fastener disposed through an axis of the particular gear and through the plenum plate **155**. In alternative embodiments, studs may be mounted (e.g., welded) on to the plenum plate **155** over which the gears **145** and **160** may be mounted. In any event, the gears **145** and **160** may be free-spinning gears mounted to the plenum plate **155** without penetrations through the side housing **105** (e.g., into a sanitary volume below the pre-cooked food product **125**).

In the illustrated embodiment of the roller grill **100**, the plenum plate **155** include one or more ventilation holes **195** that allow fluid (e.g., airflow) communication between the plenum **102***a* and a volume defined between the bottom housing **110** and the drip plate **180** and also defined between the side housing **105**. In some embodiments, airflow may be circulated between the plenum **102***a* and an ambient airspace through, for example, the ventilation holes **195** and one or more louvered openings in the bottom housing **110**.

In the illustrated embodiment, a retainer plate **190***a* (e.g., the retainer plate **915** shown in FIG. **9**A) may be mounted over the bushing **135***a* through attachment (e.g., mechanical) with the side housing **105**. The retainer plate **190***a* may sandwich the bushing **135***a* against the side housing **105**, thereby preventing (all or partially) rotational movement of the bushing **135***a* during movement (e.g., rotation) of the heating tubes **120**.

FIG. **1**B illustrates heating elements **150***a* (e.g., heaters with spade terminals) to which wires may be coupled and thereby electrically coupled to a power source. The heating elements **150***a* may, in some embodiments, be an electric resistance heater installed through the heating tube **120** (e.g., all or partially) that may generate heat power to increase a temperature of an outer surface of the heating tube **120**. In some embodiments, each heating tube **120** may include an individual heating element **150***a*. Alternatively, heating elements **150***a* may be installed in every other heating tube **120** (e.g., alternating heating tubes **120**) or otherwise.

In the illustrated roller grill **100**, the idler gears **145** are mounted below and engaged with the heating tube gears **140**. Further, the illustrated roller grill **100** includes a drive gear **165** disposed on a shaft **170** of a motor **175** including a fan **178** (shown in FIG. **1**D) that may be mounted in a bottom cavity of the roller grill **100** (defined by the side housings **105***a* and **105***b*, the drip plate **180**, and the bottom housing **110**). The drive gear **165** contactingly engages a transfer gear **160** within a series of transfer gears **160** to transfer rotational motion of the shaft **170** to the transfer gears **160**. Although three transfer gears **160** are illustrated in FIG. **1**C, alternative embodiments may include more or fewer transfer gears **160**. In some embodiments, one or more of the transfer gears **160** may be helical spur gears (e.g., helical gear **800**).

As illustrated, one of the transfer gears **160** may be engaged with one or more of a plurality of idler gears **145** disposed across a width of the side housing **105**. As illustrated, the idler gears **145** may be spaced evenly across the plenum plate **155**. The roller grill **100** also includes heating tube gears **140** that are coupled (e.g., inserted into) to respective heating tubes **120**. For example, as illustrated, there may be a 1:1 ratio of heating tube gears **140** and heating tubes **120**. In some embodiments, one or more of the idler gears **145** and/or heating tube gears **140** may be helical spur gears (e.g., helical gear **800**).

As illustrated, a cover plate **185***a* may be disposed in the plenum **102***a* and mounted to a top interior surface of the side housing **105**. In some embodiments, the cover plate **185***a* may cover ends of the heating tube gears **140**. In some embodiments, the cover plate **185***a* may be mounted adjacent a gear head portion of the heating tube gear **140** such that a concave portion extends into the gear head portion adjacent a beveled surface (e.g., as shown in FIG. **9**B). In some embodiments, electrical wiring coupled to the respective heating elements **150***a* inserted through the heating tube **120** may be installed within a volume defined by the concave portion, thereby saving space within the plenum **102***a*.

The gears **140**, **145**, **160**, and **165** may, in some embodiments, be spur gears. In some embodiments, the gears **140**, **145**, **160**, and **165** may be helical spur gears. In some embodiments, the gears **140**, **145**, **160**, and **165** may be non-metallic, such as, for example, a high-temperature plastic. In some embodiments, for example, one or more gears **140** may be a high-temperature plastic such as, for example, polystyrene, nylon, TEFLON™, polyethylene, polypropylene, polyvinyl chloride, polytetrafluoroethylene (PTFE), and other plastic material) that has a continual duty max temperature rating of between about 250° F. (121° C.) and about 500° F. (260° C.). In some embodiments, for example, one or more gears **145**, **160**, and/or **165** may be a high-temperature plastic that has a continual duty max temperature rating of between about 120° F. (49° C.) and about 200° F. (93° C.).

In some embodiments, the gears **140**, **145**, **160**, and **165** (and other rollers described herein, such as gears **225** and **230** and pulleys **325***a*, **330***a*, as some examples) may be self-lubricating. For example, in some embodiments having non-metallic gears **140**, **145**, **160**, and **165**, a material that forms the gears **140**, **145**, **160**, and **165** may be impregnated with or otherwise contain a lubricant material, such as, for example, silicon, or other lubricant material. During operation of the roller grill **100**, the lubricant material may exude from one or more of the gears **140**, **145**, **160**, and **165**, thereby providing for decreased failure rates due to lack of lubricant between the gears **140**, **145**, **160**, and **165** and other components (e.g., chains, belts, or other components).

Turning to FIG. **1**E, a side view of a non-drive side of the roller grill **100** is illustrated. In some embodiments, only one side housing **105***a* may enclose (at least partially) one or more gears and other components of the direct drive assembly. In alternative embodiments, both side housings **105***a* and **105***b* may enclose (at least partially) a portion of one or more (e.g., two) direct drive assemblies as described above. For example, there may be two motors **175** with each motor **175** driving (e.g., rotating) half of a total number of heating tubes **120** via independent direct drive assemblies. Each independent direct drive assembly may be enclosed within separate side housings **105***a* and **105***b*.

As illustrated, one of the plenums **102***b* enclosed by the side housing **105***b* (shown in FIG. **1**E) is substantially free of gears and other direct drive assembly components. As illustrated, the heating tube **120** may include heating element **150***b* extending from this end of the tube **120** and may extend through the side housing **105***b* and be secured to the side housing **105***b* by a bushing **135***b* (as described above). The bushing **135***b* may be sandwiched against an interior surface of the side housing **105***b* by a retainer plate **190***b* (as described above). In the illustrated embodiment, a cover plate **185***b* is mounted to the side housing **105***b* and adjacent the bushing **135***b*. In some embodiments, a bearing **197** may be mounted between the bushing **135***b* and the retainer plate **190***b* so as to, for example, provide a bearing (e.g., wear) surface between the bushing **135***b* and the retainer plate **190***b*.

In operation, the motor **175** of the roller grill **100** may rotate the shaft **170**, which in turn rotates the drive gear **165**. The drive gear **165**, in turn, transfers rotational movement to the transfer gears **160**. One of the transfer gears **160** is engaged with one or more of the idler gears **145** such that rotational movement is transferred from the transfer gears **160** to the engaged idler gear **145**. The engaged idler gear **145** is also in contacting engagement with at least one of the heating tube gears **140**, and transfers rotational movement to the at least one heating tube gear **140**. Rotational movement is thus transferred to each of the idler gears **145** and heating tube gears **140**, thereby rotating the heating tubes **120**.

FIGS. **2**A-**2**D illustrate views of an example embodiment of a roller grill **200** including a belt drive assembly including one or more worm gears. FIG. **2**A shows that the roller grill **200** includes a side housing **205** and a bottom housing **210** that is attached to and disposed between lower regions of plates of the side housing **205** and a corresponding side housing on an opposite end of the roller grill **200** (not shown). Referring now to FIG. **2**B, the weight of the roller grill **200** is supported by multiple legs **215** that are mounted underneath and near corners of the bottom housing **210**.

FIGS. **2**A-**2**B illustrate the roller grill **200** further including multiple heating tubes **220** that are disposed parallel to one another, across a volume defined between upper regions of opposite panels of the two side housings **205**, and above the bottom housing **210**. An end of each heating tube **220** extends through a respective hole within the panel of the side housing **205** into a plenum space **223** provided by the side housing **205**. In some embodiments, the width of the plenum space **223** is approximately 1.625 inches (4.128 cm). Within the plenum space **223**, each heating tube **220** and is engaged with a respective spur gear **225** included within the belt drive assembly. In some examples, each spur gear **225** is mounted in the end of the respective heating tube **220** and is maintained on the end by a respective bushing **250** and/or other components. In some examples, the spur gears **225** may be helical spur gears. Within the plenum space **223**, the spur gears **225** are further engaged with worm gears **230** disposed adjacent (e.g., beneath) the spur gears **225** and mounted on a shaft **235** that extends along at least a portion of the width of the roller grill **200**.

In some embodiments, the ratio of spur gears **225** to worm gears **230** is 1:1. In some embodiments, the ratio of spur gears **225** to worm gears **230** is 2:1 or another ratio. In some embodiments, a spur gear **225** may be a helical spur gear. In some embodiments, a worm gear **230** may be a screw worm gear. In some embodiments, the shaft **235** may be coupled to the side housing **205** by one or more bearing blocks **260**.

FIG. **2**C illustrates that the shaft **235** is further coupled to a timing pulley **240** having multiple teeth disposed on a cylindrical surface that engage multiple teeth protruding from a surface of a timing belt **245**. The timing belt **245** sequentially engages multiple components of the belt drive assembly that may be fully or partially disposed within the bottom housing **210** of the roller grill **200**. For example, such components include, as illustrated, a first pulley **255**, a timing gear **270** having multiple teeth disposed on a circumferential surface and mounted on a shaft of a motor **265**, and a second pulley **275** disposed vertically higher than the first pulley **255**. In some examples, one or both of the pulleys **255** or **275** can be a timing pulley (i.e., with a grooved circumferential surface). In some examples, one or both of the pulleys **255** or **275** may have substantially smooth outer cylindrical surfaces.

During operation of the roller grill **200**, the motor **265** generates rotary motion of the heating tubes **220** by using the timing belt **245** to transfer rotary motion to the worm gears **230** engaged with the spur gears **225**. Power generated by the motor **265** drives rotation of the timing gear **270** mounted on the shaft of the motor **265**, which, by engagement of the teeth disposed on the surface of the timing gear **270** with the teeth protruding from the surface of the timing belt **245**, drives rotation of the timing belt **245**. Thus, in the illustrated embodiment, the timing belt **245** extends from the bottom housing **210** through the panel of the side housing **205** and into the plenum space **223** provided by the side housing **205** to engage the timing pulley **240**. Alternatively, the motor **265** may be mounted elsewhere in or on the roller grill **200** (e.g., in the plenum space **223** or otherwise).

Engagement of the teeth protruding from the surface of the timing belt **245** with teeth disposed on the surface of the timing pulley **240** drives rotation of the timing pulley **240**, which in turn rotates the shaft **235**. Rotary motion of the shaft **235** drives rotation of the worm gears **230**, which consequently drives rotation of the spur gears **225** due to their engagement with the worm gears **230**, and further drives rotation of the heating tubes **220** that are coupled to the spur gears **225**.

In some embodiments, one motor **265** may be coupled to two belt drive assemblies located at opposing sides of the roller grill **200**. In some embodiments, a first motor **265** may be coupled to a first belt drive assembly located at a first side of the roller grill **200**, while a second motor **265** may be coupled to a second belt drive assembly located at a second side of the roller grill **200**. In other embodiments, there may be two (or more) belt drive assemblies, with each assembly driving a subset of a total number of heating tubes **220** of the roller grill **200**. Each belt drive assembly may drive the corresponding subset of heating tubes **220** from the same end of the roller grill **200** or from opposed ends.

Referring now to FIG. **2**D, in some embodiments, a cover plate **280** may be attached to the side housing **205**, such that the cover plate **280** is adjacent to the spur gears **225** and the worm gears **230**. The cover plate **280** is disposed to cover various components of the drive assembly (i.e., spur gears **225**, worm gears **230**, and other components) and is visible when the side housing **205** is displaced from the roller grill **200**. The cover plate **280** may further serve as a heat sink that absorbs heat radiated from the heating tubes **220** and/or the drive assembly components, thereby transferring heat away from the drive assembly components and transferring heat to, for example, the plenum space **223** provided the side housing **205** or an ambient space exterior to the roller grill **200**.

FIGS. **3**A-**3**B illustrate views of another example embodiment of a roller grill **300** utilizing a belt drive assembly. The roller grill **300** includes a side housing **305** and a bottom housing **370** that is attached to and disposed between lower regions of panels of the side housing **305** and a corresponding side housing on an opposite end of the roller grill **300** (not shown). The weight of the roller grill **300** is supported by multiple legs **310** that are mounted underneath and near ends of the bottom housing **370**. The roller grill **300** further includes multiple heating tubes **355** that are disposed parallel to one another, across a defined volume between upper regions of opposite panels of the two side housings **305**, and above the bottom housing **370**. The heating tubes **355** are further positioned sufficiently close to one another so as to allow a pre-cooked food product **365** to simultaneously rest atop two adjacent heating tubes **355**. One or more annular shaped dividers **360** may be mounted on each heating tube **355** in order to prevent contact between two pre-cooked food products **365** positioned along common heating tubes **355** or to restrict lateral movement of a pre-cooked food product **365** resting atop the heating tubes **355**.

In some embodiments, an end of each heating tube **355** extends through a respective hole within the panel of the side housing **305** into a plenum space **357** provided by the side housing **305**, where the heating tubes **355** are coupled to one or more belt drive assemblies. In this example, the roller grill **300** includes two belt drive assemblies, a first belt drive assembly **301***a* and a second belt drive assembly **301***b*. In alternative embodiments, however, the roller grill **300** may include only one belt drive assembly or multiple (e.g., two or more) belt drive assemblies. The first belt drive assembly **301***a* includes, as illustrated, a timing belt **315***a*, multiple timing pulleys **325***a*, multiple upper idler pulleys **330***a*, two lower idler pulleys **340***a*, a tensioning pulley **335***a*, and a timing gear **345***a*. However, in alternative embodiments, the first belt drive assembly **301***a* may include more or fewer of these listed components. The second belt drive assembly **301***b* includes, as illustrated, a timing belt **315***b*, multiple timing pulleys **325***b*, multiple upper idler pulleys **330***b*, two lower idler pulleys **340***b*, a tensioning pulley **335***b*, and a timing gear **345***b*. However, in alternative embodiments, the second belt drive assembly **301***b* may include more or fewer of these listed components.

In the illustrated embodiment, the timing belts **315***a* and **315***b* include teeth protruding from a circumferential surface that are adapted to engage teeth disposed on a surface of one or more corresponding timing pulleys **325***a*, **325***b*. The timing belts **315***a* and **315***b* are secured on the one or more corresponding timing pulleys **325***a* and **325***b* by one or more bushings **320***a* and **320***b*. Alternatively, one or both of the timing belts **315***a* and **315***b* may be smooth belts, with no teeth or other protrusions on a circumferential surface.

In some embodiments, the teeth protruding from a first surface of the timing belt **315***a*, **315***b* engage the teeth disposed on the surface of one or more timing pulleys **325***a*, **325***b* alternate with a second surface of the timing belt **315***a*, **315***b* engaging one or more upper idler pulleys **330***a*, **330***b*. Following engagement of the timing belt **315***a*, **315***b* with the one or more timing pulleys **325***a*, **325***b* and the one or more upper idler pulleys **330***a*, **330***b*, the teeth protruding from the surface of the timing belt **315***a*, **315***b* engage teeth disposed on a surface of a tensioning pulley **335***a*, **335***b*, which may be mounted on a vertically adjustable, spring-loaded bracket assembly **343***a*, **343***b*. The bracket assembly **343***a*, **343***b* allows the tensioning pulley **335***a*, **335***b* to be adjusted vertically, thereby further allowing adjustment of tension in the timing belt **315***a*, **315***b*. In some embodiments, the roller grill **300** may not include the tensioning pulley **335***a*, **335***b* and the bracket assembly **343***a*, **343***b*.

In some embodiments, the belt drive assemblies **301***a* and **301***b* can include one or more lower idler pulleys **340***a*, **340***b*. Following engagement of the teeth protruding from the surface of the timing belt **315***a*, **315***b* with the teeth disposed on the surface of the tensioning pulley **335***a*, **335***b*, the teeth protruding from the surface of the timing belt **315***a*, **315***b* engage teeth disposed on the surface of the timing gear **345***a*, **345***b*. The timing gear **345***a*, **345***b* may be coupled to a motor (not shown) located in the bottom housing **370** of the roller grill **300** that drives rotary motion of the timing belt **315***a*, **315***b*.

In some embodiments, one or more of the upper idler pulleys **330***a*, **330***b* may be coupled to a plenum plate **350**, which can serve as a heat sink that transfers heat away from the timing belt **315***a*, **315***b* and timing pulleys **325***a*, **325***b*.

In some embodiments, a louver **375** may be disposed along the bottom surface of the bottom housing **370**, allowing cool air to pass into the bottom housing **370** and cool the motor and any other drive components disposed within the bottom housing.

Referring now to FIG. **3**B, in some embodiments, a plenum plate **380** may be attached to each side housing **305**. Various components of the drive assembly, such as, for example, the timing gears **345***a* and **345***b*, the idler pulleys **340***a* and **340***b*, and other components, may be mounted on (e.g., via mechanical fasteners) on the plenum plate **380**. The plenum plate **380** may further serve as a heat transfer surface that absorbs heat radiated from the heating tubes **355** and the drive assembly components, thereby transferring heat away from the drive assembly components. In some embodiments, the plenum plate **380** may include one or more ventilation holes **395** allowing fluid (e.g., airflow) communication between the plenum **357** and a volume defined underneath the heating tubes **355** and within the bottom housing **210**. Such airflow may also be communicated through the louvers **375**. The roller grill **300** may also include multiple bushings **390** that are respectively mounted over the ends of the multiple heating tubes **355** and that, for example, prevent the timing pulleys **325***a*, **325***b* from moving inward on the multiple heating tubes **355**. Further, the bushings **390**, which may be similar to, for instance, the bushing **900** shown in FIG. **9**A, may provide a bearing surface for the heating tubes **355** to rotate within during operation of the roller grill **300**. In some examples, the plenum plate **380** may have a thermal conductivity that is greater than or equal to 200 Btu/(hrft° F.) (346 W/(mK)) at a temperature of 250° F. (121° C.).

During operation of the roller grill **300**, one or more motors (located within the bottom housing **370**, not shown in FIGS. **3**A-**3**B) drive rotation of the heating tubes **355** via the belt drive assemblies **301***a*, **301***b*. In some embodiments, a single motor may drive both belt drive assemblies **301***a*, **301***b*. In other embodiments, each belt drive assembly **301***a*, **301***b* (and other belt drive assemblies), may each be driven by a dedicated motor.

Power generated by the motor drives rotation of the timing gear **345***a*, **345***b* mounted on a shaft (not shown in FIGS. **3**A-**3**B) of the motor, which, by engagement of the teeth protruding from the surface of the timing belt **315***a*, **315***b* with teeth disposed on the surface of the timing gear **345***a*, **345***b*, drives rotary motion of the timing belt **315***a*, **315***b*. Engagement of teeth protruding from the surface of the timing belt **315***a*, **315***b* with teeth disposed on the surface of the timing pulleys **325***a*, **325***b* further provides rotary motion to the timing pulleys **325***a*, **325***b*, which consequently rotate the heating tubes **355**. Engagement of the teeth protruding from the timing belt **315***a*, **315***b* with teeth and surface of the timing belt **315***a*, **315***b* disposed on the surface of the idler pulleys **330***a*, **330***b*, **340***a*, **340***b* and the tensioning pulley **335***a*, **335***b*, further rotates the idler pulleys **330***a*, **330***b*, **340***a*, **340***b* and the tensioning pulley **335***a*, **335***b*, respectively.

In some embodiments, the arrangement of the timing pulleys **325***a*, **325***b* and one or more of the idler pulleys **330***a*, **330***b*, **340***a*, **340***b*, the tensioning pulley **335***a*, **335***b*, and the timing gear **345***a*, **345***b* creates a series of alternating timing belt heating cycles and timing belt cooling cycles, respectively. In some embodiments, the timing belt heating cycles are provided by heat radiated from the timing pulleys **325***a*, **325***b*. When heat is generated within the heating tubes **355** by, for example, electric resistive heating elements, the heat is transferred to various components of the roller grill assembly **300**, including the bushings **390** and the timing pulleys **325***a*, **325***b*. As the timing belt **315***a*, **315***b* engages with the timing pulleys **325***a*, **325***b*, the timing belt **315***a*, **315***b* absorbs heat from the timing pulleys **325***a*, **325***b* (i.e., the timing pulleys **325***a*, **325***b* transfer heat to the timing belt **315***a*, **315***b*).

In some embodiments, the timing belt **315***a*, **315***b* may be made from low heat conducting material. For example, the timing belt **315***a*, **315***b* may be insulated from the transfer of heat from, for instance, the heating tubes **355** through the timing pulleys **325***a*, **325***b*.

In some embodiments, the timing belt cooling cycles are provided by heat absorbed by one or more of the idler pulleys **330***a*, **330***b*, **340***a*, **340***b*, the tensioning pulley **335***a*, **335***b*, and the timing gear **345***a*, **345***b*. For example, as the timing belt **315***a*, **315***b* engages with the idler pulleys **330***a*, **330***b*, **340***a*, **340***b*, the idler pulleys **330***a*, **330***b*, **340***a*, **340***b* absorb heat from the timing belt **315***a*, **315***b* (i.e., the idler pulleys **330***a*, **330***b*, **340***a*, **340***b* transfer heat away from the timing belt **315***a*, **315***b*). In some embodiments, the roller grill **300** may not include the lower idler pulleys **340***a*, **340***b* or the tensioning pulley **335***a*, **335***b*. Thus, in some embodiments, the presence of one or more of the idler pulleys **330***a*, **330***b*, **340***a*, **340***b* and the tensioning pulley **335***a*, **335***b* may determine the length and total cooling effect of the cooling cycle.

In some examples, the thermal conductivity of the timing pulleys **325***a*, **325***b* is less than that of one or more of the idler pulleys **330***a*, **330***b*, **340***a*, **340***b*, the tensioning pulley **335***a*, **335***b*, and the timing gear **345***a*, **345***b*. For example, in some embodiments, the thermal conductivity of the timing pulleys **325***a*, **325***b* may be less than or equal to 17 Btu/(hrft° F.) (29 W/(mK)) at a temperature of 250° F. (121° C.), while the thermal conductivity of one or more of the idler pulleys **330***a*, **330***b*, **340***a*, **340***b*, the tensioning pulley **335***a*, **335***b*, and the timing gear **345***a*, **345***b* may be greater than or equal to 200 Btu/(hrft° F.) (346 W/(mK)) at a temperature of 250° F. (121° C.). In some instances, the cooling cycle can drop the temperature of the timing belt **315***a*, **315***b* by up to 50° F. (10° C.). In some examples, the alternating heating cycles and cooling cycles may extend the life of the timing belt **315***a*, **315***b*. For example, the cooling cycle may provide the timing belt **315***a*, **315***b* with a life of up to six years, whereas a drive chain, in contrast, may need to be changed once per year.

In some embodiments, the timing pulleys **325***a*, **325***b* may be a low heat conductive material, such as plastic. In some embodiments, the idler pulleys **330***a*, **330***b* may be a high heat conductive material, such as aluminum. In some embodiments, the idler pulleys **340***a*, **340***b* may be a low heat conductive material, such as plastic. In some embodiments, the timing gear **345***a*, **345***b* may be a high heat conductive material, such as aluminum.

FIGS. **4A-4C** illustrate views of another example embodiment of a roller grill **400** utilizing a chain drive assembly. The roller grill **400** includes two side housings **405** (one shown in FIG. **4A**), and the weight of the roller grill **400** is supported by multiple legs **410** that are mounted underneath and near corners of a bottom housing. The roller grill **400** also includes multiple heating tubes and multiple sprockets **420** that are respectively coupled to ends of the multiple heating tubes. In some embodiments, a chain **415** provides rotary motion to the heating tubes by engaging the sprockets **420**. The chain **415** is driven by one or more motors within a bottom housing of the roller grill **400** (not shown in FIGS. **4A-4B**) as the chain **415** engages a drive gear **430** coupled to the motor. In this example, the roller grill **400** includes one chain drive assembly; however, in alternative embodiments, the roller grill **400** may include more than one chain drive assembly.

In some embodiments, one motor may be coupled to two chain drive assemblies located at opposing sides of the roller grill **400**. In some embodiments, a first motor may be coupled to a first chain drive assembly located at a first side of the roller grill **400**, while a second motor may be coupled to a second chain drive assembly located at a second side of the roller grill **400**.

In some embodiments, a lubricator **425** may be attached to the side housing **405** and disposed around the chain **415** as the chain **415** travels through the drive assembly. In some examples, the lubricator **425** may be unattached to the side housing **405** and mounted on the chain **415**. In this example, the lubricator **425** can have pins **450** disposed adjacent external surfaces of the lubricator **425** (e.g., protruding from the housing **405**) that prevent the lubricator **425** from moving past a fixed distance from the drive sprocket **430**. The lubricator **425**, therefore, may be free-floating on the chain **415** (e.g., unattached to the side housing **405**) and substantially prevented from moving with movement of the chain **415** towards the drive sprocket **430**.

In some embodiments, the lubricator **425** may be approximately 4 inches (10 cm) long in length. The lubricator **425** includes two lubricant blocks **435**, a shell cover plate **440**, and a clam shell cover plate **445**. Each lubricant block **435** has two grooves cut into a surface of the lubricant block **435**, the surface of each lubricant block **435** disposed adjacent to and facing the mirrored surface of the other lubricant block **435**. In some examples, when the surfaces of the two lubricant blocks **435** are disposed adjacent to and facing each other, the opening created by the grooves allows the plates **455** and rollers **460** of the chain **415** to travel through the lubricator **425** with engaging contact with the lubricant blocks **435**.

Each lubricant block **435** is further impregnated with lubricant. In some embodiments, the lubricator **425** cleans and lubricates the chain **415** substantially constantly such that an appropriate amount of lubricant is provided to the chain **415**, while excess lubricant on the chain **415** is removed. For example, the lubricator **425** can replace lubricant that may have evaporated from the chain **415** over time due to heat transferred to the chain **415**, and/or the lubricator **425** can remove lubricant that may have congealed on the chain **415** over time. As the chain **415** enters the lubricant blocks **435** during operation of the roller grill **400**, excess lubricant on the chain **415** is scraped away (e.g., by external edges of the lubricant blocks **435**, the "I"-shaped recess defined between the lubricant blocks **435**, or other edge surface). As the chain **415** continues to pass through and in contact with the facing surfaces of the lubricant blocks **435**, lubricant impregnated in the lubricant blocks **435** is disposed on the chain **415**. The clam shell cover plate **440**, in some embodiments, can serve as a spring that urges the two lubricant blocks **435** together to maintain their contact. Further, the shell cover plate **440** may maintain the lubricant blocks **435** disposed around the chain **415** as the chain **415** travels through the lubricator **425**.

In some embodiments, the lubricator **425** can be used with any chain-driven system that needs regular lubrication maintenance to function properly. For example, the lubricator **425** may be used on a bicycle chain, a motorcycle chain, a food heating assembly chain, or otherwise. Further, although the lubricant blocks **435** are illustrated as separate portions, in some embodiments, the lubricator **425** may have a single lubricant block with one or more of the illustrated channels and/or grooves formed therethrough.

FIG. **4C** illustrates a sectional view of the lubricator **425**. As illustrated, the lubricant blocks **435** are urged together by the shell cover plate **440** to form an interface at matching surfaces of the blocks **435**. Upon interface of the lubricant blocks **435**, grooves **470*a*** and **470*b*** define a channel **472**. In some embodiments, the channel **472** may extend an entire length of the blocks **435** with openings at each end surface of the lubricant blocks **435**. As illustrated, a portion of the chain **415**, such as, for example, a plate **455** of the chain **415**, may fit within the channel **472**. In some embodiments, the channel **472** may be sized so as to contactingly engage the portion of the chain **415** (e.g., the plates **455**) as the chain **415** is moved through the lubricator **425**. In such a fashion, lubricant impregnated into the lubricant blocks **435** may be transferred to the chain **415**.

As illustrated, upon interface of the lubricant blocks **435**, grooves **475*a*** and **475*b*** define another channel **477**. In some embodiments, the channel **477** may extend the entire length of the blocks **435** with openings at each end surface of the lubricant blocks **435**. As with the channel **472**, the channel **477** may be sized so as to contactingly engage the portion of the chain **415** (e.g., the plates **455**) as the chain **415** is moved through the lubricator **425**. In such a fashion, lubricant impregnated into the lubricant blocks **435** may be transferred to the chain **415** in cooperation with the channel **477**.

As illustrated, ridges **480*a*** and **480*b*** may be formed in the lubricant blocks **435** in between the grooves **470*a*** and **475*a***, and grooves **470*b*** and **475*b***, respectively. The ridges **480*a*** and **480*b*** may be sized to allow a portion of the chain **415** (e.g., the rollers **460**) to move through another channel **482** formed between the lubricant blocks **435**. As illustrated, the channel **482** may be open to the channels **472** and **477**, thereby defining a substantially "T" shaped opening through the lubricant blocks **435**. In some embodiments, lubricant from the lubricant blocks **435** may be transferred to the rollers **460** as the chain **415** is moved through the lubricant blocks **435** through, for instance, contacting engagements with the ridges **480*a*** and **480*b***.

In some embodiments, lubricant on the chain **415** may be removed by the lubricant blocks **435** as the chain **415** enters into and/or moves through the lubricant blocks **435**. For instance, edges on distal surfaces of the lubricant blocks **435** that define openings into the channels **472** and **477** may remove excess and/or used lubricant from the chain **415** as the chain **415** is moved over, and in contact with, such edges. In some embodiments, excess and/or used lubricant may also be removed from the chain **415** as the portions of the chain **415** (e.g., the plates **455** and rollers **460**) contactingly engage the lubricant blocks **435** at the grooves **470*a***, **470*b***, **475*a***, and **475*b***, and at the ridges **480*a*** and **480*b***.

FIGS. **5A-5B** illustrate views of example embodiments of a roller grill tube assembly **500**, **550** that may be used with a roller grill, such as one or more of roller grills **100**, **200**, **300** and/or **400**. Referring now to FIG. **5A**, in some embodiments, a roller grill tube assembly **500** includes a heating tube **505**, a sprocket **510** coupled to an end of the heating tube **505**, and a bushing **515**. In some embodiments, the sprocket **510** is installed over the heating tube **505** (e.g., press fit over the tube **505**). In some embodiments, the bushing **515** may be a bearing inserted into the sprocket **510** that acts as a thrust bearing that prevents (all or partially) metal-to-metal contact between the sprocket **510** and other metal components of a roller grill.

In some examples, the sprocket **510** may allow the roller grill tube assembly **500** to operate with a roller grill utilizing a chain drive assembly, such as the roller grill **400**. During operation of a roller grill, the bushing **515** provides a surface to transfer heat away from the heating tube **505** and the sprocket **510**, thereby reducing the wear of the sprocket **510** and a chain (e.g., the chain **415**) engaged with the sprocket **510**. In some embodiments, the bushing **515** can include a notch **520** that engages with a ridge of the heating tube **505** or a ridge of the sprocket **510** to prevent or reduce slippage of the bushing **515**. In some examples, the bushing **515** is a TEFLON™ bushing.

Referring now to FIG. **5**B, in some embodiments, a roller grill assembly **550** may include a heating tube **555**, a pulley flange **560** coupled to an end of the heating tube **555**, a timing pulley **565** coupled to the end of the heating tube **555**, and a bushing **570**. The bushing **570** may, in some embodiments, extend past the timing pulley **565** to contact a retainer plate (not shown), such as, for instance, the cover plate **280**. In some embodiments, the bushing **570** may be TEFLON™ or another bearing material. In some embodiments, the timing pulley **565** may allow the roller grill tube assembly **550** to operate with a roller grill utilizing a belt drive assembly, such as the roller grill **300**. In some examples, the pulley flange **560** may prevent the timing pulley **565** from sliding inward on the heating tube **555**. In some examples, the pulley flange **560** is made of plastic (e.g., TEFLON™) or steel (e.g., stainless or carbon).

FIGS. **6**A-**6**D illustrate views of example embodiments of a roller grill **600** having a chain drive assembly or a roller grill **600** having a belt drive assembly. As shown in FIG. **6**A, the illustrated roller grill **600** includes a side housing **605**, multiple heating tubes **610**, and multiple sprockets **615** that are respectively coupled to ends of the multiple heating tubes **610**. In some embodiments, as illustrated, a bearing (such as the bushing **515**) may be press-fit into each heating tube **610** and provide a wear surface with a retainer plate (not shown) so as to prevent metal-to-metal contact with the sprockets **615** and, for instance, a retainer plate.

The roller grill **600** further includes a chain glide **620** having multiple glide recesses **625**. In some embodiments, the chain glide **620** can be made of a bearing material, such as plastic, bronze, or other wearable material. In some embodiments, the chain glide **620** can have a serpentine shape that causes the chain **630** to engage more than one tooth of the sprockets **615**. For example, the chain glide **620** may cause the chain **630** to engage with two or three teeth of the sprockets **615**, rather than a single tooth in the absence of the chain glide **620**.

Engagement of the chain **630** with more than one tooth of the sprockets **615** reduces the probability of the chain **630** being displaced from the sprockets **615**. In some examples, engagement of the chain **630** with more than one tooth of the sprockets **615** reduces the frictional wear on any given point of the chain **630** and on any given tooth of the sprockets **615** by distributing forces between the chain **630** and the sprockets **615** across multiple teeth of the sprockets **615**. In some embodiments, each of the glide recesses **625** may have side skirts that maintain the position of the chain **630** on the sprockets **615**. In some examples, this can prevent damage of one or more of the chain **630**, of the sprockets **615**, or of other components of the chain drive assembly.

During operation of the roller grill **600**, the chain **630** provides rotary motion to the heating tubes **610** by engaging the sprockets **615** that are coupled to the ends of the heating tubes **610**. The chain **630** is driven by one or more motors within a bottom housing of the roller grill **600** (not shown in FIGS. **6**A-**6**B) as the chain **630** engages a drive gear a coupled to the one or more motors. As the chain **630** engages the sprockets **615**, the chain **630** is contacted and further guided towards the sprockets **615** by the chain glide **620**, which causes the chain **630** to engage multiple teeth of the sprockets **615**. While the chain **630** is engaged with the teeth of the sprockets **615**, the glide recesses **625** can prevent the chain **630** from slipping off of the sprockets **615**.

Referring now to FIG. **6**B, in some embodiments, the roller grill **600** can include one or more rollers **635** coupled to the side housing **605** and disposed above and in contact with the chain **630** and between the sprockets **615**. The one or more rollers **635** can cause the chain **630** to engage more than one tooth of the sprockets **615**. In some embodiments, the position of the one or more rollers **635** can increase the engagement of the chain **630** with the teeth on two separate sprockets **615** simultaneously. In some examples, a roller **635** can be positioned above and in contact with the chain **630** and between every two sprockets **615**. In some embodiments, the chain **630** may be longer than a conventional chain for a roller grill due to increased contact between the chain **630** and the teeth of the sprockets **615**.

During operation of the roller grill **600**, the chain **630** provides rotary motion to the heating tubes **610** by engaging the sprockets **615** that are coupled to the ends of the heating tubes **610**. The chain **630** is driven by one or more motors within a bottom housing of the roller grill **600** (not shown in FIGS. **6**A-**6**B) as the chain **630** engages a drive gear a coupled to the one or more motors. As the chain **630** engages the sprockets **615**, the chain **630** is contacted and further guided towards the sprockets **615** by the rollers **635**, which cause the chain **630** to simultaneously engage multiple teeth of adjacent sprockets **615**. While the chain **630** is engaged with the teeth of the sprockets **615**, the rollers **635** can also help in preventing the chain **630** from slipping off of the sprockets **615**.

Turning to FIG. **6**C, another embodiment of the roller grill **600** is shown but with a belt-drive assembly that uses a timing belt **650** engaged with gears **660** to drive (e.g., rotate) one or more heating tubes **610**. This embodiment of the roller grill **600** further includes a belt glide **622** having multiple glide recesses **627**. In some embodiments, the belt glide **620** can be made of a bearing material, such as plastic, bronze, or other wearable material. In some embodiments, the belt glide **622** can have a serpentine shape that causes the belt **650** to engage more than one tooth of the gears **660**. For example, the belt glide **622** may cause the belt **650** to engage with two or three teeth of the gears **660**, rather than a single tooth in the absence of the belt glide **622**.

Engagement of the belt **650** with more than one tooth of the gears **660** reduces the probability of the belt **650** being displaced from the gears **660**. In some examples, engagement of the belt **650** with more than one tooth of the gears **660** reduces the frictional wear on any given point of the belt **650** and on any given tooth of the gears **660** by distributing forces between the belt **650** and the gears **660** across multiple teeth of the gears **660**. In some embodiments, each of the glide recesses **627** may have side skirts that maintain the position of the belt **650** on the gears **660**. In some examples, this can prevent damage of one or more of the belt **650**, of the gears **660**, or of other components of the belt drive assembly.

During operation of this embodiments of the roller grill **600** shown in FIG. **6**C, the belt **650** provides rotary motion to the heating tubes **610** by engaging the gears **660** that are coupled to the ends of the heating tubes **610**. The belt **650** is driven by one or more motors within a bottom housing of the roller grill **600** (not shown in FIG. **6**C) as the belt **650** engages a drive gear coupled to the one or more motors. As the belt **650** engages the gears **660**, the belt **650** is contacted and further guided towards the gears **660** by the belt glide **622**, which causes the belt **650** to engage multiple teeth of each of the gears **660**. While the belt **650** is engaged with the teeth of the gears **660**, the glide recesses **627** can prevent the belt **650** from slipping off of the gears **660**.

Turning to FIG. **6**D, another embodiment of the roller grill **600** is shown but with a belt-drive assembly that uses a timing belt **650** engaged with gears **660** to drive (e.g., rotate) one or more heating tubes **610**. This embodiment of the roller grill **600** can include one or more rollers **637** coupled to the side housing **605** and disposed above and in contact with the belt **650** and between the sprockets **615**. The one or more rollers **637** can cause the belt **650** to engage more than one tooth of the gears **660**. In some embodiments, the position of the one or more rollers **637** can increase the engagement of the belt **650** with the teeth on two separate gears **660** simultaneously. In some examples, a roller **637** can be positioned above and in contact with the belt **650** and between every two gears **660**. In some embodiments, the belt **650** may be longer than a conventional belt for a roller grill due to increased contact between the belt **650** and the teeth of the gears **660**.

During operation of the roller grill **600**, the belt **650** provides rotary motion to the heating tubes **610** by engaging the gears **660** that are coupled to the ends of the heating tubes **610**. The belt **650** is driven by one or more motors within a bottom housing of the roller grill **600** (not shown in FIG. **6**D) as the belt **650** engages a drive gear coupled to the one or more motors. As the belt **650** engages the gears **660**, the belt **650** is contacted and further guided towards the gears **660** by the rollers **637**, which cause the belt **650** to simultaneously engage multiple teeth of adjacent gears **660**. While the belt **650** is engaged with the teeth of the gears **660**, the rollers **637** can also help in preventing the belt **650** from slipping off of the gears **660**.

FIGS. **7**A-**7**B illustrate example embodiments of a bearing block that may be used to support a rotating shaft of a roller grill, such as, for example, the roller grill **200** illustrated in FIGS. **2**A-**2**D. For instance, in some embodiments, one or more of the illustrated bearing blocks **700** and/or **750** may be used to support (e.g., rotatingly) the shaft **235** on which the worm gears **230** are disposed. For example, in some embodiments, a bearing block **700** or a bearing block **750** may be mounted on the roller grill **200** at or near the illustrated locations of the illustrated bearing blocks **260** and may take the place of the bearing blocks **260**. For instance, in some embodiments, there may be four bearing blocks **700** and/or **750** mounted and arranged to receive a bearing attached to the shaft **235** therethrough. Alternatively, there may be more or fewer bearing blocks **700** and/or **750** arranged on the roller grill **200** to receive the shaft **235** therethrough.

Turning to FIG. **7**A, the illustrated bearing block **700** includes a vertical block **715** inserted through a yoke **705** and coupled thereto. In some embodiments, the vertical block **715** may be directly coupled to the yoke **705**, such as, for example, by welding, adhesive, or other technique. A shaft with an attached bearing, such as the shaft **235**, may be inserted through a bore **720** of the vertical block **715** and be supported (e.g., rotatingly) by a bearing (e.g., a roller bearing or other type of bearing) statically mounted within the bore **720** of the vertical block **715**. Thus, in some embodiments, the shaft **235** may rotate with reduced friction in the bearing block **700**. In some embodiments, the vertical block **715** may comprise a press fit bearing for the shaft **235** made of, for instance, stainless steel, cold rolled steel, or other appropriate material.

The yoke **705**, as illustrated, includes two winged extensions **713**, with each extension **713** having a mount hole **710** therethrough. In some embodiments, the yoke **705** may be directly coupled to the side housing **205** through mechanical fasteners (e.g., sheet metal screws or otherwise) inserted through the mount holes **710**. In alternative embodiments, the yoke **705** may be directly coupled to a plenum plate, such as the plenum plate **350**, through mechanical fasteners (e.g., sheet metal screws or otherwise) inserted through the mount holes **710**.

As illustrated, the vertical block **715** includes a mounting ledge **730**. In some embodiments, the mounting ledge **730** may interface with a portion of the roller grill **200**, such as, for example, a plate on which the worm gears **230** may be mounted. In some embodiments, for example, the mounting ledge **730** may provide for an increased alignment of the bearing block **700** when mounted to the roller grill **200**.

The illustrated bearing block **700** also includes a threaded bore **725**. In some embodiments, a retainer or cover plate (such as the retainer plate **930** illustrated in FIG. **9**B) may be attached to the bearing block **700** by a mechanical fastener threaded into the bore **725** and through a tab **940** of the retainer plate. This may, in some embodiments, provide or help provide for the bearing block **700** to be held substantially stationary during operation of the roller grill. For instance, the bearing block **700** may be held substantially stationary so that it does not rotate when the shaft **235** rotates and also is not urged laterally in parallel to the longitudinal axis of the shaft **235** due to thrust forces exerted by rotation of the worm gears **230**.

Turning to FIG. **7**B, the illustrated bearing block **750** includes a bearing ring **770** coupled to a yoke **755**. In some embodiments, for example, the bearing ring **770** may be integral with the yoke **755**, with each component manufactured of a metal or plastic, such as noryl (PPO) plastic (30% glass filled). A shaft, such as the shaft **235**, may be inserted through a bore **775** of the bearing ring **770** and be supported (e.g., rotatingly) by a bearing (e.g., a roller bearing or other type of bearing) statically mounted within the bore **775** of the bearing ring **770**. Thus, in some embodiments, the shaft **235** may rotate with reduced friction in the bearing block **750**. In some embodiments, the bearing ring **770** may comprise a press fit bearing for the shaft **235** and may include a torque surface **780**, as illustrated. In some embodiments, the torque surface **780** may prevent (all or partially) rotation of the bearing in the bore **775** during rotation of the shaft **235** within the bearing, as well as longitudinal movement of the bearing under a thrust force applied by the worm gears **230**.

The yoke **755**, as illustrated, includes two winged extensions **760**, with each extension **760** having a mount slot **765** therethrough. In some embodiments, the yoke **755** may be directly coupled to the side housing **205** through mechanical fasteners (e.g., sheet metal screws or otherwise) inserted through the mount slots **765**. In alternative embodiments, the yoke **755** may be directly coupled to a plenum plate, such as the plenum plate **350**, through mechanical fasteners (e.g., sheet metal screws or otherwise) inserted through the mount slots **765**.

As illustrated, the bearing ring **770** includes a mounting ledge **790**. In some embodiments, the mounting ledge **790** may interface with a portion of the roller grill **200**, such as, for example, a plate on which the worm gears **230** may be mounted. In some embodiments, for example, the mounting ledge **790** may provide for an increased alignment of the bearing block **750** when mounted to the roller grill **200** (e.g., a plenum plate).

The illustrated bearing block **750** also includes a threaded bore **785**. In some embodiments, a retainer or cover plate (such as the retainer plate **930** illustrated in FIG. **9**B) may be attached to the bearing block **750** by a mechanical fastener threaded into the bore **785** and through a tab **940** of the retainer plate. This may, in some embodiments, provide or help provide for the bearing block **750** to be held substantially stationary during operation of the roller grill. For instance, the bearing block **750** may be held substantially stationary so that it does not rotate when the shaft **235** rotates and also is not urged laterally in parallel to the longitudinal axis of the shaft **235** due to thrust forces exerted by rotation of the worm gears **230**.

FIGS. **8**A-**8**D illustrate an example helical gear **800** that may be used in a roller grill, such as, for example, the roller grill **200** illustrated in FIGS. **2**A-**2**D. In some embodiments of the roller grill **200**, for instance, the helical gear **800** may be coupled to a heating tube **220** (or other heating tube) and used to drive (e.g., rotate) the heating tube **220**. For example, the helical gear **800** may be driven by the spur gear **225** and mounted on the shaft **235**.

As illustrated, the helical gear **800** includes an outer diameter surface **810** coupled to (e.g., attached to or integral with) a gear head **805** having multiple teeth **815** disposed around an outer surface of the gear head **805**. A bore **820** extends through the gear head **805** and outer diameter surface **810** and shares a centerline with the gear head **805** and the outer diameter surface **810**. As illustrated, the teeth **815** may be angled to form a helical gear (e.g., at about a 5° angle offset). In some embodiments, there may be 21 teeth **815**, with each tooth **815** having a pitch diameter of about 1.2 inches (3.1 cm), an outside diameter of about 1.3 inches (3.3 cm), a root diameter of about 1.08 inches (2.74 cm), and a tooth thickness at the pitch diameter of about 0.1 inches (0.3 cm). Further, in some embodiments, the diameter of the bore **820** is about 0.75 inches (1.91 cm).

As illustrated in FIG. **8**D, an end of the helical gear **800** that may be coupled to a heating tube includes a beveled surface **825** around a circumference of the outer diameter surface **810**. In some embodiments, the beveled surface **825** may be set-off at an angle of about 30° from an interior surface of the outer diameter surface **810**. Alternatively, other angular offsets are possible. In some embodiments, the beveled surface **825** may allow a heating element to be more easily inserted through the helical gear **800** from the heating tube **220**.

As further illustrated in FIG. **8**D, the gear head **805** also includes a beveled surface **830** around a circumference of the gear head **805**. In some embodiments, the beveled surface **830** may be set-off at an angle of about 45° from an interior surface of the gear head **805**. Alternatively, other angular offsets are possible. In some embodiments, a retainer or cover plate (such as the retainer plate **930**) may include a concave portion **935** that protrudes into the gear head **805** adjacent the beveled surface **830**. Thus, there may be more space allowed for wiring coupled to a heating element passing through the heating tube **220**.

In some embodiments, the helical gear **800** may be coupled to the heating tube **220** (or another heating tube) as follows. First the outer diameter surface **810** may be inserted (e.g., all or partially) into the heating tube **220** until an end of the heating tube **220** is at or adjacent the gear head **805**. Next, the heating tube **220** may be punched into the outer diameter surface **810** (e.g., by compressing the heating tube **220** into the outer diameter surface **810** and/or inserting a davit (not shown) through the heating tube **220** and outer diameter surface **810**). Next, the assembly including the helical gear **800** and heating tube **220** may be rotated, for example, about 180°. The heating tube **220** may be punched again into the outer diameter surface **810** (e.g., by installing the heating tube **220** over the outer diameter surface **810**) at a location about 180° about from the first punch location. In such a manner, the helical gear **800** may be coupled to the heating tube **220**.

FIGS. **9**A-**9**B illustrate an example bushing **900** that may be used in a roller grill, such as, for example, one or more of the roller grills **100**, **200**, **300**, **400**, and/or **600**. In some embodiments, for example, the bushing **900** may be used as a bearing surface through which a heating tube (such as, for instance, the heating tube **120**) may be inserted. As illustrated, the bushing **900** includes a pair of tubulars **910** connected by a web **905**. Although FIG. **9**A shows two tubulars **910**, more or fewer tubulars **910** may be connected by the web **905**. In some embodiments, the bushing **900** may be installed against an end plate of a roller grill, such as the side housing **205**, such that the web **905** is mounted adjacent an outboard surface of the side housing **205** (e.g., facing a side plenum space of the roller grill) and the tubular portions **910** are inserted through holes in the side housing **205**.

As illustrated in FIG. **9**A, a retainer plate **915** may also be mounted in a roller grill substantially adjacent the bushing **900**. The retainer plate **915** may include a number of apertures **925** receiving the tubulars **910**. For instance, in some embodiments, the retainer plate **915** may be a single piece that extends (all or partially) a width of the roller grill with a 1:1 ratio of apertures **925** to heating tubes. In some embodiments, the retainer plate **915** may prevent (all or partially) the bushing **900** from movement (e.g., rotational) during rotation of heating tubes in the roller grill.

Turning to FIG. **9**B, an example embodiment of the bushing **900** is illustrated with the roller grill **200**. Alternatively, the bushing **900** may be used in the roller grill **100** illustrated in FIG. **1**. As illustrated, the bushing **900** may be inserted through the side housing **205** such that the web **905** is in contacting engagement with an outboard surface of the side housing **205**. The retainer plate **915** may be inserted over the tubulars **910** that extend into the plenum space adjacent the outbound surface of the side housing **205**, thereby sandwiching the web **905** against the side housing **205**. In some embodiments, the retainer plate **915** may be attached (e.g., mechanically) to the side housing **205**.

As further illustrated in FIG. **9**B, the retainer plate **930** may be mounted adjacent the gear head **805** of the helical gear **800** such that the concave portion **935** extends into the gear head **805** adjacent the beveled surface **830**. In some embodiments, electrical wiring coupled to a heating element (not shown) inserted through the heating tube **220** may be installed within a volume defined by the concave portion **935**, thereby saving space within the plenum **223**.

A number of embodiments have been described. Nevertheless, it will be understood that various modifications may be made. For example, various combinations of the components described herein may be provided for embodiments of similar apparatus. For instance, although belts and chains are shown in the illustrated embodiments, other types of looped surfaces (e.g., continuous looped surfaces) may be used in place of belts or chains. Accordingly, other embodiments are within the scope of the present disclosure.

What is claimed is:

1. A roller grill for heating a pre-cooked food product, comprising:

a housing structure adapted to support the roller grill;

a plurality of tubes having outer surfaces adapted to transfer heat to the pre-cooked food product;

a plurality of rollers mounted in a row, each roller mounted on an end of a corresponding tube and comprising a plurality of detented projections extending from a circumferential surface of the roller;

a drive assembly, comprising:

a motor comprising a shaft, the motor adapted to generate rotational power through the shaft at a first rotational speed; and

a fan coupled to the motor, the fan and motor mounted in a bottom portion of the housing structure that is positioned beneath the plurality of tubes;

a chain coupled to the shaft and contactingly engaged with the detented projections of the plurality of rollers, the chain adapted to transfer the rotational power to the plurality of rollers at a second rotational speed; and

an elongated chain guide mounted to the housing structure, the elongated chain guide formed as a continuous serpentine surface that extends across a side portion of this housing above the plurality of rollers, the continuous serpentine surface comprising alternating peaked portions and recessed portions arranged along a length of the elongated chain guide, the peaked portions extending from the housing structure at locations between consecutively mounted rollers in the row of the plurality of rollers and in contacting engagement with the chain to bias the chain in contacting engagement with at least two detented projections of each roller of the plurality of rollers mounted in the row, wherein

the fan is positioned to circulate an airflow from an ambient space, through a vent in the bottom portion of the housing, and to the side portion of the housing to cool the chain.

2. The roller grill of claim **1**, wherein the first and second rotational speeds are substantially identical.

3. The roller grill of claim **1**, wherein the plurality of rollers comprise a plurality of sprockets.

4. The roller grill of claim **3**, wherein the plurality of detented projections comprise a plurality of teeth extending from respective circumferential surfaces of the plurality of sprockets, and

the chain is contactingly engaged with the plurality of teeth.

5. The roller grill of claim **4**, wherein the chain is contactingly engaged with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

6. The roller grill of claim **4**, wherein the elongated chain guide contactingly guides the chain into contacting engagement with at least two teeth of each sprocket of the plurality of sprockets mounted in the row.

7. The roller grill of claim **4**, wherein the peaked portions are arranged between adjacent sprockets of the plurality of sprockets in the row.

8. An apparatus for heating a pre-cooked food product, comprising:

a housing structure comprising a bottom housing portion and side housing portions and adapted to support the apparatus;

a plurality of tubes having outer surfaces adapted to transfer heat to the pre-cooked food product;

a motor comprising a shaft, the motor adapted to generate rotational power through the shaft at a first rotational speed;

a fan coupled to the motor, the fan and motor mounted in the bottom housing portion that is positioned between the side housing portions and beneath the plurality of tubes;

a plurality of sprockets mounted to corresponding ends of the plurality of tubes, the sprockets operable to receive the generated rotational power and transfer the generated rotational power to the plurality of tubes;

a timing chain that is operable to transfer the generated rotational power from the motor to the plurality of sprockets;

a continuous elongated serpentine surface mounted to the housing structure in one of the side housing portions and extending across the side housing portion above the plurality of sprockets, the continuous elongated serpentine surface comprising alternating peaked portions and recessed portions arranged along a length of the continuous elongated serpentine surface, the peaked portions extending from the housing structure at locations between consecutively mounted sprockets of the plurality of sprockets and in contact with the timing chain and operable to urge the timing chain into contacting engagement with at least two teeth of each of the plurality of sprockets; and

the fan is positioned to circulate an airflow from an ambient space, through a vent in the bottom housing portion, and to the side housing portion to cool the timing chain.

9. The apparatus of claim **8**, wherein the elongated serpentine surface comprises a chain guide.

10. The apparatus of claim **9**, wherein peaked portions of the chain guide are arranged between adjacent sprockets of the plurality of sprockets.

11. The roller grill of claim **1**, wherein the housing structure comprises a plenum panel that serves as a heat sink to receive heat from one or more of the plurality of tubes.

12. The roller grill of claim **1**, wherein the recessed portions are positioned adjacent the plurality of rollers and in contacting engagement with the chain.

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